physicsUK
Smarter practice. Stronger understanding

WORKSHEETS
ATTEMPT | CHECK | CORRECT | IMPROVE

OCR A AS Resistivity 1 Calculations and Applications worksheet

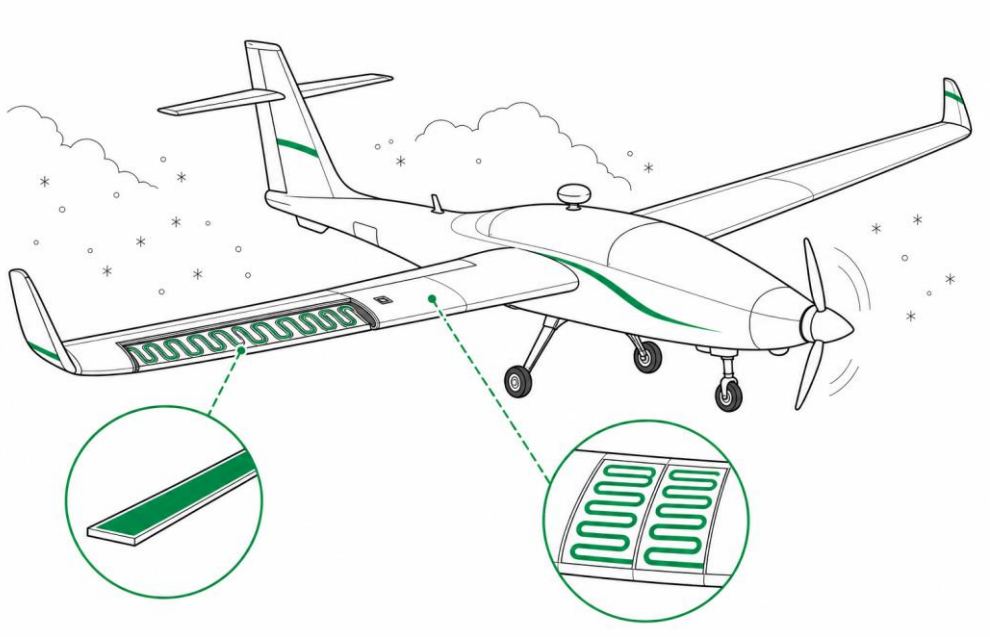
35–40 minutes independent practice + 15–20 minutes review | 42 marks

Specification points covered

- 4.2.4(a)(i) Define resistivity using $R = \rho L / A$.
- 4.2.4(b) Describe variation of resistivity of metals and semiconductors with temperature.
- 4.2.5(a) Use and apply power equations $P = IV$, $P = I^2R$, and $P = V^2 / R$.

PolarSky aircraft anti-icing system

A long-endurance survey aircraft uses thin metallic ribbons in its wing leading edges to prevent ice forming during polar flights.
Treat each ribbon as uniform and use the stated operating temperature when comparing resistivities.



Context diagram: a polar survey aircraft, rectangular heater ribbon and twin anti-icing panels.

1. Resistivity and conductor geometry

1. Define resistivity and state its SI unit. [2 marks]

2. The resistance of a uniform conductor is modelled by $R = \rho L/A$. State what area A represents and explain why the relation applies only when the conductor is uniform. [2 marks]

3. A round constantan lead has length 6.2 m, diameter 0.32 mm and resistivity 4.9×10^{-7} Ω m. Calculate its resistance. [2 marks]

2. Direct calculations and scaling

4. One flat anti-icing ribbon has length 8.4 m, width 2.8 mm, thickness 45 μm and resistivity 1.15×10^{-6} Ω m. Calculate its resistance. [3 marks]

5. A replacement ribbon must have resistance 64 Ω. It is made from the same material, with length 8.4 m and width 2.8 mm. Calculate the required thickness in μm. [3 marks]

6. Two round wires are made from the same material. Wire Q is twice the length of wire P and has half its diameter. Determine R_Q/R_P. [2 marks]

3. Material meaning and comparison

7. A test sample has length 0.850 m and diameter 0.360 mm. The p.d. across it is 5.60 V when the current is 0.0820 A. Determine its resistivity. [3 marks]

8. A technician claims that a longer piece of the same wire has a larger resistivity because it has a larger resistance. Explain the error in this claim. [2 marks]

9. A design wire has length 2.4L and diameter 1.5d compared with a reference wire of length L and diameter d. Both use the same material. Determine the ratio $R_{design}/R_{reference}$. [2 marks]

4. Temperature and panel resistance

10. Describe how increasing temperature affects the resistivity of a metal and of a semiconductor. Use particle behaviour to explain one of these trends. [2 marks]

11. A wing panel contains two ribbon sections in series. Section P has length 3.4 m and width 3.0 mm. Section Q has length 2.6 m and width 2.0 mm. Both are 50 µm thick and have resistivity 1.10×10^{-6} Ω m. Calculate the total resistance and the current from a 48 V supply. [3 marks]

12. Calculate the power transferred by the panel in Question 11. [2 marks]

5. Parallel panels and design power

13. Two identical wing panels are connected in parallel across the 48 V supply. Calculate the total current and total power. [2 marks]

14. One panel develops an open circuit while the other remains connected to the ideal 48 V supply. State how the current and power in the working panel change, and determine the new total power. [2 marks]

15. A redesigned aircraft needs a total heater power of 120 W from two identical panels connected in parallel across 48 V. Each panel uses ribbon of resistivity 1.15×10^{-6} Ω m, width 2.6 mm and thickness 50 μm. Calculate the ribbon length required in each panel. [3 marks]

6. Material choice

16. A further design requires a 5.0 m ribbon, width 2.5 mm, thickness 40 µm and resistance 50 Ω at 20 °C. Calculate the required resistivity and select the closest candidate from the table. [2 marks]

Candidate	Resistivity at 20 °C / Ω m	Change as temperature rises
A	1.00×10^{-6}	small increase
B	1.68×10^{-8}	increase
C	3.0×10^{-5}	decrease

17. The heater is metallic and is connected to a constant-p.d. supply. Explain why its current and power are greatest just after switch-on and then decrease as the ribbon warms. [2 marks]

7. Operating data

18. During flight, one 5.0 m ribbon of width 2.5 mm and thickness 40 µm takes 0.840 A from 48.0 V. Calculate its operating resistivity. The 20 °C value is 1.00×10^{-6} Ω m. Determine the percentage increase and assess whether the result is consistent with a warm metallic ribbon. [3 marks]

Review and improve

□ I convert diameter, width and thickness before calculating cross-sectional area.
□ I distinguish resistance of a sample from resistivity of its material.
□ I combine resistivity with series, parallel and constant-p.d. power reasoning.