physicsUK
Smarter practice. Stronger understanding

WORKSHEETS
ATTEMPT | CHECK | CORRECT | IMPROVE

OCR A AS Electrical Power and Energy worksheet

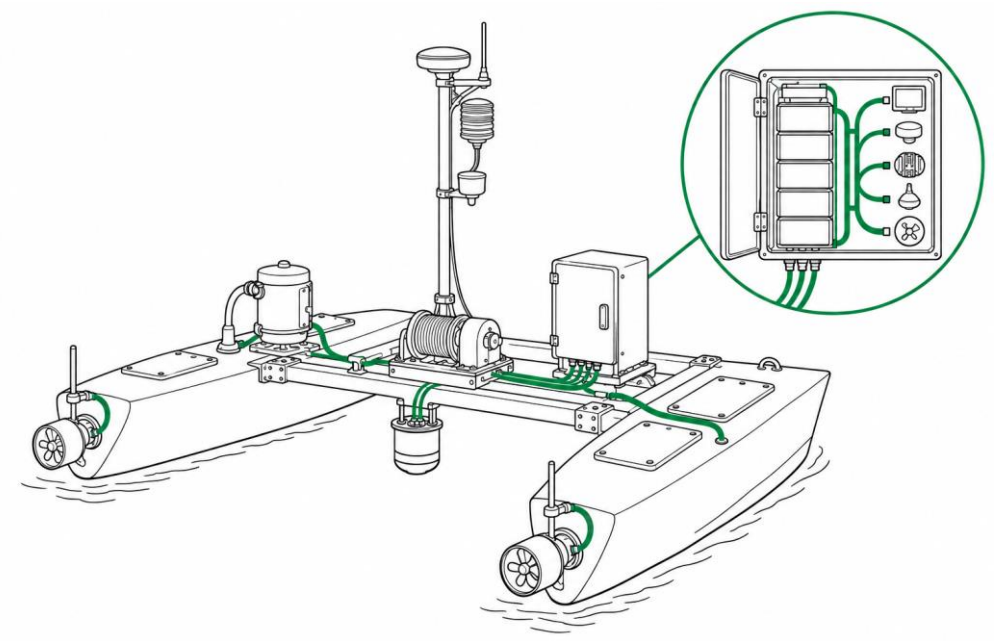
35–40 minutes independent practice + 15–20 minutes review | 38 marks

Specification points covered

- 4.2.5(a) Use and apply power equations $P = IV$, $P = I^2R$, and $P = V^2 / R$.
- 4.2.5(b) Use energy transfer equation $W = VIt$.
- 4.2.5(c) Recognise the kilowatt-hour (kWh) as a unit of energy and calculate the cost of electrical energy.

Pelagia autonomous ocean-research vessel

Pelagia uses a shore-charged battery and a 96 V electrical system to operate its sonar, sampling pump, thrusters, computer and emergency equipment.
Use the operating data to calculate rates of energy transfer, mission energy and charging cost, then make engineering decisions from the results.



Context diagram: the Pelagia autonomous survey vessel and its battery distribution system.

1. Electrical power in vessel systems

1. State what is meant by electrical power. [1 mark]

2. The sonar array draws a current of 2.40 A from the vessel's 96.0 V supply. Calculate its electrical power. [1 mark]

3. The thruster control unit transfers electrical energy at 1.80 kW from the 96.0 V supply. Calculate its operating current and select the most suitable fuse from 15 A, 20 A and 25 A. [2 marks]

4. An instrument-bay heater is rated at 720 W when connected to a 48.0 V converter. Calculate the heater resistance and current. Use your values to verify the power using $P = I^2R$. [3 marks]

2. Energy transfer and cable heating

5. The heater in Question 4 operates for 7.5 minutes. Calculate the energy transferred in joules using W = VIt. [2 marks]

6. Explain the difference between electrical power and electrical energy, using the heater as an example. [2 marks]

7. The deck winch takes a current of 14.0 A. Its supply cable has resistance 0.420 Ω. Calculate the thermal power transferred in the cable and the energy transferred to the cable during a 6.0 minute lift. Give the energy in kJ. [2 marks]

8. Explain why $P = I^2R$ is useful for the heating of the winch cable, while $P = IV$ is used for the total electrical input to the winch motor. [2 marks]

3. Mission energy budget

9. The table shows the electrical loads during an 8.0 h survey. Calculate the total operating time in hours for the sampling pump and for the thruster system. [2 marks]

Device	Power / kW	Operating pattern during an 8.0 h mission
Sonar array	0.230	continuous
Sampling pump	0.720	25 min in every hour
Thruster system	1.80	62% of the mission
Data computer	0.160	continuous

10. Calculate the energy used by each device in the table and hence the total mission energy in kWh. [4 marks]

4. Battery capacity and charging cost

11. The battery stores 18.0 kWh when fully charged. The control system must leave 15% of this energy unused as a reserve. Determine whether the mission can be completed while keeping the reserve, and calculate the remaining energy margin. [2 marks]

12. At the harbour, electrical energy costs £0.31 per kWh. Calculate the charging cost represented by one mission's energy use and the cost for 120 identical missions. [2 marks]

5. Heating and resistance

13. A corroded connector carries an approximately constant current of 25.0 A. Its resistance increases from 0.0120 Ω to 0.0300 Ω. Calculate the power transferred in the connector before and after corrosion, and determine the factor by which the power increases. [3 marks]

14. Explain why the increased connector resistance in Question 13 creates a risk of further heating when the current remains approximately constant. [2 marks]

15. Two test resistors are connected separately across 96.0 V. Resistor A has resistance 24.0 Ω and resistor B has resistance 18.0 Ω. Calculate the power transferred in each and identify which transfers energy at the greater rate. [2 marks]

6. Operating data and equipment choice

16. A floodlight is labelled 240 W. During a test it takes 2.35 A from 96.0 V. Calculate its measured power and the percentage by which this is below the labelled value. [2 marks]

17. An emergency pump must transfer at least 1.20 MJ of electrical energy during an 18 minute test without taking more than 16.0 A from the 96 V supply. Use the manufacturer data to evaluate all three candidates and select the only suitable pump. [4 marks]

Candidate	Manufacturer data at 96 V
A	operating current 12.0 A
B	resistance 5.50 Ω
C	rated power 1.05 kW

Review and improve

□ I choose the power equation from the quantities that are known.
□ I distinguish power in watts from energy in joules or kilowatt-hours.
□ I convert seconds, minutes and hours before calculating energy or cost.