Energy, Power and Resistance Questions – OCR A Level Physics

Praneel Physics

1. State Ohm's law. **(P)**

Working and Answer:
Ohm's Law: The current through an ohmic conductor is directly proportional to the potential difference across it, provided temperature is constant.

$$V = IR$$

2. Define resistance and give its SI unit. **(P)**

Working and Answer:
Resistance is a measure of how much a component opposes the flow of electric current.

$$R = \frac{V}{I}$$

Unit: Ohm (Ω)

3. State the equation linking power, voltage, and current. **(P)**

Working and Answer:

$$P = IV$$

4. State the equation linking energy transferred, power and time. **(P)**

Working and Answer:

$$E = Pt$$

5. What is meant by the term "ohmic conductor"? **(P)**

Working and Answer:
An ohmic conductor has constant resistance; it obeys Ohm's Law (i.e., $V \propto I$) at constant temperature.

6. Calculate the resistance of a bulb with 230 V across it and 1.15 A current. **(PP)**

Working and Answer:

$$R = \frac{V}{I} = \frac{230}{1.15} = 200\,\Omega$$

7. A 12 V battery is connected to a 3 Ω resistor. Calculate the current and power. **(PP)**

Working and Answer:

$$I = \frac{V}{R} = \frac{12}{3} = 4\,\text{A}$$

$$P = IV = 4 \times 12 = 48\,\text{W}$$

8. A resistor dissipates 20 W of power for 10 s. Calculate the energy transferred. **(PP)**

Working and Answer:

$$E = Pt = 20 \times 10 = 200\,\text{J}$$

9. A 4 Ω resistor has 2 A of current flowing for 3 minutes. Calculate the energy. **(PP)**

Working and Answer:

$$P = I^2R = 2^2 \times 4 = 16\,\text{W}$$

$$E = Pt = 16 \times 180 = 2880\,\text{J}$$

10. Calculate the power dissipated in a 10 Ω resistor carrying 3 A. **(PP)**

Working and Answer:

$$P = I^2R = 3^2 \times 10 = 90\,\text{W}$$

11. A 60 W lamp operates at 240 V. Calculate the current and resistance. **(PPP)**

Working and Answer:

$$I = \frac{P}{V} = \frac{60}{240} = 0.25\,\text{A}$$

$$R = \frac{V}{I} = \frac{240}{0.25} = 960\,\Omega$$

12. Describe and explain the I–V graph for a filament lamp. **(PPP)**

Working and Answer:
Graph: Curve starts linear, then flattens.
Explanation: As current increases, the filament heats up, increasing resistance, so the rate of current increase slows.

13. A kettle is rated at 2.2 kW and runs for 4 minutes. Calculate the energy used. **(PPP)**

Working and Answer:

$$E = Pt = 2200 \times 240 = 528000\,\text{J}$$

14. Describe two differences between ohmic and non-ohmic components. **(PPP)**

Working and Answer:
1. Ohmic: V–I graph is straight line; Non-ohmic: V–I graph is curved.
2. Ohmic: Resistance is constant; Non-ohmic: Resistance varies with current/voltage.

15. A 6 V battery powers a motor drawing 1.2 A for 10 seconds. Calculate the energy transferred. **(PPP)**

Working and Answer:

$$E = IVt = 6 \times 1.2 \times 10 = 72\,\text{J}$$

16. Explain why filament bulbs do not obey Ohm's law. **(PPPP)**

Working and Answer:
As current increases, the filament temperature increases. Higher temperature causes increased resistance, violating the condition for Ohm's law (constant temperature).

17. Derive $P = I^2R$ using Ohm's law. **(PPPP)**

Working and Answer:
From Ohm's law: $V = IR$
Substitute into $P = IV$:

$$P = I(IR) = I^2R$$

18. Derive an expression for power in terms of voltage and resistance. **(PPPP)**

Working and Answer:
From Ohm's law: $I = \frac{V}{R}$
Substitute into $P = IV$:

$$P = V\left(\frac{V}{R}\right) = \frac{V^2}{R}$$

19. Describe how the resistance of an NTC thermistor varies with temperature. **(PPPP)**

Working and Answer:
As temperature increases, resistance of an NTC thermistor decreases.
Explanation: More charge carriers become available, reducing opposition to current.

20. Compare the energy transferred in two resistors (5 Ω and 10 Ω) both carrying 3 A for 2 minutes. **(PPPP)**

Working and Answer:

$$E = I^2RtE_5 = 3^2 \times 5 \times 120 = 5400\,\text{J}E_{10} = 3^2 \times 10 \times 120 = 10800\,\text{J}$$

Answer: The 10 Ω resistor transfers twice the energy.

21. A wire has length 2 m, cross-sectional area 1.5×10^{-6} m^2, and resistivity $1.7 \times 10^{-8}\,\Omega$m. Calculate resistance. **(PPPPP)**

Working and Answer:

$$R = \rho\frac{L}{A} = \frac{1.7 \times 10^{-8} \times 2}{1.5 \times 10^{-6}} = 0.0227\,\Omega$$

22. A 100 W appliance runs on 230 V. How much energy does it use in 5 minutes? **(PPPPP)**

Working and Answer:

$$E = Pt = 100 \times 300 = 30,000\,\text{J}$$

23. State and explain the effect of temperature on resistance of a metal wire. **(PPPPP)**

Working and Answer:
As temperature increases, the ions in the metal lattice vibrate more.
This increases the number of collisions between electrons and ions, increasing resistance.