

Q1. Unit of current [1]

- Ampere / amp / A (1)
-

Q2. Charge equation [3]

(a) $Q = I \times t$ (1)

(b) Calculation:

- $t = 30$ s (already in seconds) (1)
 - $Q = 2 \times 30 = 60$ C (1)
-

Q3. Potential difference [2]

(a) Volt / V (1)

(b) Voltmeter (1)

Q4. Resistance equation [1]

- $V = I \times R$ (1)
-

Q5. Current in circuit [2]

- $I = V \div R = 12 \div 6 = 2$ A (2)
-

Q6. Series circuits [2]

(a) Current is the same everywhere (1)

(b) Potential difference is shared across components (1)

Q7. Parallel circuits [2]

- Current splits between branches (1)
 - More current flows through the branch with lower resistance (1)
(accept: current in branches adds to total current)
-

Q8. Resistance of a wire [2]

(a) $R = \rho \times L \div A$ (1)

(b) Factor: temperature (1)

(accept: material / resistivity of wire)

Q9. Resistors in parallel [3]

- Total resistance decreases (1)
 - Current has more than one path (1)
 - Total resistance is less than smallest resistor (1)
-

Q10. Charge flow [4]

(a) Coulomb / C (1)

(b)

- Convert: 2 minutes = 120 s (1)
 - $Q = I \times t = 0.5 \times 120 = 60$ C (2)
-

Q11. Power in devices [4]

(a) $P = V \times I$ (1)

(b)

- Substitution: 230×8 (1)
 - Answer: 1840 W (2)
-

Q12. Power rating [2]

- Maximum power appliance is designed to use (1)
 - Shows energy transferred per second during normal use (1)
-

Q13. Energy transfer [4]

(a) $E = P \times t$ (1)

(b)

- Convert power: $60 \text{ W} = 0.060 \text{ kW}$ (1)
 - Energy = $0.060 \times 5 = 0.30 \text{ kWh}$ (2)
-

Q14. UK mains [2]

(a) 230 V (1)

(b) 50 Hz (1)

Q15. Plug wiring [6]

(a) Live wire colour = brown (1)

(b) Earth wire function: safety feature (1)

- Carries current to the ground if a fault occurs (1)
(c) Explanation:
- Earth wire provides a path for current (1)
- Prevents metal case becoming live (1)
- Reduces risk of electric shock (1)

Q16. Current & Charge [4]

(a) $Q = I \times t$ (1)

(b)

- Convert: 2 min = 120 s (1)
 - Substitution: $Q = 3.5 \times 120$ (1)
 - Answer: 420 C (1)
-

Q17. Resistance [4]

(a) $V = I \times R$ (1)

(b)

- Substitution: $R = 12 \div 0.5$ (1)
 - Calculation = 24 (1)
 - Unit: ohms / Ω (1)
-

Q18. I–V for filament lamp [5]

(a) Graph:

- Curve through origin (1)
- Gradient decreases at higher current (1)
(b) Explanation:
- As current increases, filament temperature rises (1)

- Resistance increases (1)
 - Therefore current does not increase proportionally to voltage (1)
-

Q19. Ohmic conductor [2]

- Current is directly proportional to potential difference (1)
 - Provided temperature remains constant (1)
-

Q20. Resistors [5]

(a) Series:

- Total resistance increases (1)
- Equal to sum of individual resistors (1)

(b) Parallel:

- Total resistance decreases (1)
 - Current has more than one path (1)
 - Total resistance less than the smallest resistor (1)
-

Q21. Diode [3]

(a) Symbol drawn correctly (triangle + line) (1)

(b) Behaviour:

- Current flows in one direction only (1)
 - Very high resistance in reverse direction (1)
-

Q22. Current from charge [3]

- Convert: 2 min = 120 s (1)
 - $I = Q \div t = 240 \div 120$ (1)
 - Answer: 2.0 A (1)
-

Q23. National Grid [5]

(a) Transformers:

- Step-up used to increase voltage (1)
 - High voltage reduces current (1)
 - Lower current reduces energy losses in cables (1)
(b)
 - Power station: step-up transformer (1)
 - Homes: step-down transformer (1)
-

Q24. Power & resistance [4]

(a) $P = I^2 \times R$ (1)

(b)

- Substitution: $4^2 \times 12$ (1)
 - $= 16 \times 12$ (1)
 - Answer: 192 W (1)
-

Q25. Kettle energy [3]

- Convert: 2.2 kW = 2200 W (1)
- Convert: 3 min = 180 s (1)
- $E = P \times t = 2200 \times 180 = 396\,000$ J (1)

Q26. a.c. vs d.c. [4]

(a)

- a.c.: current repeatedly changes direction (1)
 - d.c.: current flows in one direction only (1)
- (b)
- a.c. source: mains electricity (1)
 - d.c. source: battery / cell (1)
-

Q27. UK mains [2]

(a) 50 Hz (1)

(b) 230 V (1)

Q28. Lamp & resistor [3]

- Increasing resistance reduces current (1)
 - Less current means less power transferred to lamp (1)
 - Lamp becomes dimmer (1)
-

Q29. Charge flow [3]

- $Q = I \times t$ (1)
 - Substitution: 0.75×200 (1)
 - Answer: 150 C (1)
-

Q30. Thermistor [2]

(a) Resistance decreases as temperature increases (1)

(b) Example: temperature sensor / thermostat / car engine sensor (1)

Q31. Energy transfer [4]

(a) $E = Q \times V$ (1)

(b)

- Substitution: 500×9 (1)
 - Answer: 4500 J (1)
 - Unit J given (1)
-

Q32. Earth wire [3]

- Earth wire provides path to ground if live wire touches case (1)
 - Prevents appliance case becoming live (1)
 - Reduces risk of electric shock (1)
-

Q33. Fuses [2]

- Fuse wire melts / blows when current too high (1)
 - This breaks circuit and stops current flowing (1)
-

Q34. Heater [4]

(a)

- $P = V \times I$ (1)
- Substitution: 230×5 (1)

- Answer: 1150 W (1)
(b) Energy transfer: electrical → thermal (1)
-

Q35. Fixed resistor [4]

(a) Graph:

- Straight line through origin (1)
 - Constant gradient (1)
(b)
 - Current proportional to potential difference (1)
 - Resistance remains constant if temperature constant (1)
-

Q36. Filament lamp [5]

(a) Graph:

- Curve through origin (1)
 - Gradient decreases at higher current (1)
(b) Explanation:
 - As current increases, filament heats up (1)
 - Resistance increases (1)
 - Current no longer proportional to potential difference (1)
-

Q37. LED [2]

- LEDs are more efficient / use less energy (1)
 - Longer lifetime (1)
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Q38. Parallel circuit [3]

(a) 3 A in each branch (1)

(b)

- Current splits equally because branches are identical (1)
 - Total current = sum of branch currents (1)
-

Q39. Energy equation [4]

(a) $E = P \times t$ (1)

(b)

- Convert: $120 \text{ W} = 0.12 \text{ kW}$ (1)
 - Substitution: $0.12 \times 10 = 1.2$ (1)
 - Answer: 1.2 kWh (1)
-

Q40. Circuit breakers [3]

- Detect current above safe level (1)
- Break circuit by opening switch (1)
- Can be reset and are faster / more reliable than fuses (1)

Q41. Resistivity [3]

(a) $R = \rho \frac{L}{A}$ (1)

(b)

- Increasing cross-sectional area decreases resistance (1)
 - Because electrons have more pathways / lower resistivity effect (1)
-

Q42. Superconductors [3]

- A material with zero resistance (1)
 - Occurs below a critical temperature (1)
 - No energy is lost as heat when current flows (1)
-

Q43. Heating in resistors [2]

- Wastes energy (1)
 - Can damage components / reduce efficiency / safety hazard (1)
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Q44. a.c. and d.c. graphs [4]

(a) a.c. graph:

- Sine wave shape (1)
- Crosses above and below zero (1)

(b) d.c. graph:

- Straight horizontal line (1)
 - Constant value, above zero only (1)
-

Q45. Transformers [4]

(a) $V_p V_s = N_p N_s \frac{V_p}{V_s} = \frac{N_p}{N_s} V_s V_p = N_s N_p$ (1)

(b)

- Substitution: $V_s = N_s N_p \times V_p$
 $V_s = \frac{N_s}{N_p} \times V_p V_s = N_p N_s \times V_p$ (1)
 - $= 100 \times 500 \times 230 \frac{100}{500} \times 230$ (1)
 - $= 46 \text{ V}$ (1)
-

Q46. High-voltage transmission [3]

- High voltage means lower current (1)
 - Lower current reduces heating effect in cables (1)
 - So less energy wasted (1)
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Q47. Transformers [2]

- Step-up: increases voltage for transmission, reduces current/energy loss (1)
 - Step-down: decreases voltage to safe level for homes (1)
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Q48. Derivation of $P = I^2R$ [3]

- Start with $P = V \times I$ (1)
 - Use $V = I \times R$ (1)
 - Substitute to give $P = I^2R$ (1)
-

Q49. Metals conductors [3]

- Metals contain free (delocalised) electrons (1)
 - Electrons can move through lattice (1)
 - So charge flows easily, giving low resistance (1)
-

Q50. Hairdryer & fuse [4]

(a)

- $I = P \div V$ (1)
- $= 2000 \div 230$ (1)

- $\approx 8.7 \text{ A}$ (1)
(b) 13 A fuse (1)
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Q51. Resistance & temperature [3]

- At higher temperature, metal ions vibrate more (1)
 - Collisions between electrons and ions increase (1)
 - So resistance increases (1)
-

Q52. Potential difference [3]

- Potential difference = energy transferred per unit charge (1)
 - 1 volt = 1 joule per coulomb (1)
 - Measures how much energy a charge gains/loses moving between two points (1)
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Q53. Circuits in households [4]

(a) Parallel advantage:

- Appliances work independently / each gets full voltage (1)
- Safer & more convenient (1)

(b) Series disadvantage:

- If one component fails, circuit breaks for all (1)
 - Voltage shared, so appliances may not work properly (1)
-

Q54. Transformer efficiency [3]

- Efficiency = $\text{output} \div \text{input} \times 100$ (1)

- $480 \div 500 \times 100$ (1)
 - = 96% (1)
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Q55. a.c. in National Grid [3]

- Transformers only work with alternating current (1)
- a.c. allows voltage to be increased/decreased easily (1)
- Makes long-distance transmission efficient (1)