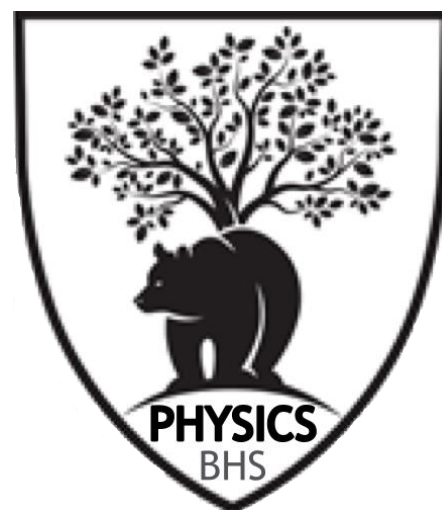


# The Berwickshire High School

## Electricity Block 3

### Power and Concepts

### Knowledge Organiser



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## 1) Key quantities and units

| Idea                               | Definition                                   | Unit             |
|------------------------------------|--|------------------|
| Current (I)                        | The rate of flow of electric charge.         | ampere (A)       |
| Charge (Q)                         | The amount of charge transferred.            | coulomb (C)      |
| Power (P)                          | The energy transferred each second.          | watt (W)         |
| Energy (E)                         | The amount of energy transferred.            | joule (J)        |
| Time (t)                           | How long the process lasts.                  | second (s)       |
| Potential difference / voltage (V) | The push that drives charge round a circuit. | volt (V)         |
| Resistance (R)                     | How much a component opposes current.        | ohm ( $\Omega$ ) |

## 2) Essential equations

| Equation    | What it's for                     | Notes                                   |
|-------------|-----------------------------------|---|
| $Q = It$    | Charge transferred in time        | $t$ must be in seconds                  |
| $P = E / t$ | Power from energy and time        | Rearranged form: $E = Pt$               |
| $P = IV$    | Power from current and voltage    | Use when you know <b>I</b> and <b>V</b> |
| $P = I^2R$  | Power from current and resistance | Convert mA to A first                   |
| $P = V^2/R$ | Power from voltage and resistance | Square the voltage first                |

## 3) Quick unit conversions

| Conversion                    | What to do       | Example         |
|-------------------------------|------------------|-----------------|
| minutes $\rightarrow$ seconds | multiply by 60   | 5 min = 300 s   |
| mA $\rightarrow$ A            | divide by 1000   | 250 mA = 0.25 A |
| A $\rightarrow$ mA            | multiply by 1000 | 0.4 A = 400 mA  |
| kW $\rightarrow$ W            | multiply by 1000 | 2.0 kW = 2000 W |

## 4) Charge and current

| Topic            | Notes   |
|------------------|---|
| What is current? | Current is the <b>rate of flow of charge</b> .                                      |
| Main equation    | $Q = It$  |
| Rearrangements   | $I = Q / t$ and $t = Q / I$   |
| Meaning of 1 A   | <b>1 ampere means 1 coulomb of charge flows each second.</b>                        |
| Units            | Q in <b>C</b> , I in <b>A</b> , t in <b>s</b>                                       |
| Worked example   | A current of <b>3 A</b> flows for <b>4 s</b> . $Q = It = 3 \times 4 = 12 \text{ C}$ |

## 5) Power and energy

| Topic          | Notes  |
|----------------|--|
| What is power? | Power is the <b>energy transferred each second</b> .   |
| Main equation  | <b><math>P = E / t</math></b>  |
| Rearrangements | <b><math>E = Pt</math> and <math>t = E / P</math></b>  |
| Units          | P in <b>W</b> , E in <b>J</b> , t in <b>s</b>  |
| Key idea       | A <b>higher power</b> appliance transfers <b>more energy each second</b> .                           |
| Worked example | A <b>60 W</b> lamp is on for <b>10 s</b> . <b><math>E = Pt = 60 \times 10 = 600 \text{ J}</math></b> |

## 6) Power, current, voltage and resistance

| Topic                   | Notes  |
|-------------------------|--|
| Power equations         | <b><math>P = IV</math>, <math>P = I^2R</math>, <math>P = V^2 / R</math></b>  |
| Which one should I use? | Know <b>V and I</b> → use <b><math>P = IV</math></b>   |
|                         | Know <b>I and R</b> → use <b><math>P = I^2R</math></b>   |
|                         | Know <b>V and R</b> → use <b><math>P = V^2 / R</math></b>  |
| Units                   | P in <b>W</b> , I in <b>A</b> , V in <b>V</b> , R in <b><math>\Omega</math></b>  |
| Worked example          | A resistor has <b><math>V = 9.0 \text{ V}</math></b> and <b><math>R = 100 \Omega</math></b> . <b><math>P = V^2 / R = 9^2 / 100 = 0.81 \text{ W}</math></b> |

## 7) Fuses and mains electricity

| Topic            | Notes  |
|------------------|--|
| What is a fuse?  | A fuse is a <b>safety device</b> that melts if the current gets too high and breaks the circuit.                             |
| Fuse equation    | <b><math>I = P / V</math></b>  |
| UK mains voltage | Mains is about <b>230 V</b>  |
| Choosing a fuse  | <b>3 A fuse up to 720 W</b>  |
|                  | <b>13 A fuse above 720 W</b>   |
| Worked example   | A <b>460 W</b> appliance on mains takes <b><math>I = P / V = 460 / 230 = 2 \text{ A}</math></b> . Choose a <b>3 A fuse</b> . |

## 8) AC and DC

| Name                     | Notes   | Example             |
|--------------------------|---|---------------------|
| AC (alternating current) | Charges <b>continually change direction</b> backwards and forwards. | mains electricity   |
| DC (direct current)      | Charges move in <b>one direction only</b> .                         | cells and batteries |

## 9) Oscilloscope traces

| Trace type | What it looks like                         | What it means                      |
|------------|--|------------------------------------|
| DC trace   | Straight horizontal line                   | Constant voltage                   |
| AC trace   | Wave going above and below the center line | Voltage changes direction and size |

## 10) Electric fields

| Topic            | Notes   |
|------------------|---|
| Field direction  | Electric field lines go from <b>positive to negative</b> .                                  |
| Arrow meaning    | Arrows show the direction of force on a <b>positive test charge</b> .                       |
| Stronger field   | Lines closer together = <b>stronger field</b> .   |
| Rule             | Field lines <b>do not cross</b> .   |
| Point charges    | Field lines spread out from a <b>positive</b> charge and go in to a <b>negative</b> charge. |
| Opposite charges | Field lines go from the <b>+ charge</b> to the <b>- charge</b> .                            |

## 11) Charged particles in fields

| Topic             | Notes  |
|-------------------|--|
| Positive particle | Moves in the <b>same direction</b> as the field arrows.  |
| Negative particle | Moves in the <b>opposite direction</b> to the field arrows.  |
| Parallel plates   | The field goes from the <b>positive plate</b> to the <b>negative plate</b> .   |
| Worked example    | If the left plate is + and the right plate is -, a <b>positive particle</b> moves right and a <b>negative particle</b> moves left. |

## 12) Quick rules

| Quick rule  | Meaning in words                           |
|---|--|
| If current stays the same and time increases → charge increases   | More time means more charge passes.        |
| If power stays the same and time increases → energy increases     | Longer time means more energy transferred. |
| If power increases → more energy transferred each second          | High power = faster energy transfer.       |
| If appliance power is higher → current is usually higher on mains | Use $I = P / V$ to check.                  |
| If a question gives mA → convert to A first                       | Needed before using power equations.       |
| If a question gives minutes → convert to seconds first            | Needed for $Q = It$ and $P = E / t$ .      |
| If the charge is positive → force is along the field              | Follow the arrows.                         |
| If the charge is negative → force is opposite the field           | Go against the arrows.                     |

### 13) Common mistakes

| <b>Common mistake</b>                 | <b>What usually goes wrong</b>  | <b>Quick fix</b>  |
|---------------------------------------|---|---|
| Time not in seconds                   | Answer is far too big or too small  | Convert minutes to seconds first                            |
| Mixing up C and A                     | Wrong unit for charge/current   | Check: charge = <b>C</b> , current = <b>A</b>               |
| Energy written in watts               | Wrong final unit  | Energy is <b>J</b> , not <b>W</b>                           |
| Leaving mA as A                       | Power answer much too large   | Divide by 1000 first  |
| Forgetting to square V or I           | Wrong answer in <b><math>P = I^2R</math></b> or <b><math>P = V^2 / R</math></b> | Square the value carefully                                  |
| No unit in final answer               | Easy mark lost  | Always write <b>C, A, s, J, W, V, <math>\Omega</math></b>   |
| Wrong fuse chosen                     | Appliance not properly protected  | Calculate current first using <b><math>I = P / V</math></b> |
| Arrows drawn the wrong way in a field | Field diagram loses marks   | Remember: <b>+ to -</b>                                     |
| Field lines crossing                  | Diagram is incorrect  | Field lines never cross                                     |