L3 ELECTRICITY
CHEAT SHEET

STUDY TIME

ABOUT THE STANDARD

- There are four topics in our level 3 electricity paper. DC circuits, capacitors, inductors, and AC circuits. DC is the rarest and usually pops up in the other topics' questions, so really there's sort of 3 and a half topics in the paper.
- In the exam you are going to want to be confident in both calculation based questions and written answers. The fun thing about the written answers is that often you can just use your formula sheet to explain what's going on. The best way to do this is write an equation, and explain the outcome, and continue this until you have your answer.
    - For example: explain what happens to the time it takes to charge a capacitor in a circuit if you add another capacitor in parallel. We've added another capacitor so what's that immediately going to affect? Capacitance. So we look at the capacitance equations, and see circuit capacitance has increased as the capacitors are in parallel. Okay, so how does overall capacitance relate to the time it takes to charge a capacitor? Look at the equations again. We see $t = RC$, so C has increased, so t must too, so the time has increased.
- For a calculation question, your formula sheet is there to help you! If you're unsure how to answer a question, write down everything you already know about the question and then what you're trying to find. Level 3 physics is a step up from level 2. In level 2 often the merit and excellence questions involved a couple of steps to find missing variables. In level 3, we do a couple of steps to find the relationships between things. We have to ask ourselves how does one thing affect another if they don't both show up in the same equation? That's where you need to think along the same lines as the written answers, and notice what is changing where, and how that can relate to what you are eventually looking for.
    - We can actually use a similar question as earlier, say, what happens to the time taken to charge a capacitor if an identical capacitor is added in parallel? Well, Looking at our equations, we know total capacitance has doubled. What's the relationship between time and capacitance? $t = RC$, so if capacitance has double, time has too.

STRATEGIES FOR SUCCESS

- Almost every year, there is a question in either capacitors or inductors that asks you to explain the shape of a graph. You want to break this down as simply as possible, so there's only two point you need to cover, **what is the shape, why is the rate of change decreasin**g.
    - For shape, your options are either exponential growth (an increasing graph) or exponential decay (a decreasing graph). As part of this you should add where the graph starts and ends. The only options for these are at zero and at maximum. For maximum chuck in the value if you know it.
    - The rate of change is the slope. It will be decreasing, so write that down. Next you want to explain why. **The reason is due to the functions of capacitors and inductors; it's what they do**. So explain it. Explaining is key, as it answers the why and how, which is the fundamental idea of physics.
- Why and how questions are abundant in this paper, and do mostly show up in capacitors and inductors

questions. Anytime you need to explain what is happening, or why, **write down how the capacitor or inductor is acting in the circuit in the conditions given, and then apply this result to the specific question being asked.**

- For example, "why does the circuit current not immediately reach maximum when the switch is closed in a circuit with an inductor?". First we explain how an inductor acts when a switch is closed. How are you going to do this? 2 things, explain using your relevant equation, and chuck in the names Faraday's Law and Lenz's Law. Even if you can't remember which law does what, chucking them both in makes you sound on to it, and it really doesn't hurt. So, when a switch is closed, what is happening?
- We have a massive change in current with it going from zero to some other number. This occurs over a small change in time relative to electrons as initally the change is almost instantaneous. The inductor then produces a large induced voltage. How do we know this? The equation $V = -L\frac{\Delta I}{\Delta t}$. What's the affect of a large induced voltage? It opposes the flow of supply current slowing it's increase down, so it can not immediately reach maximum. We know this from Faraday's and Lenz's Laws.

Notice how we simply explained what an inductor does, and then applied it to a question.

- AC Circuits is a pretty small topic. We have a bunch of equations, a reference circle or two, and resonance.
  - You don't want to get too caught up in resonance, it tends to be an excellence explanation so people like to ramble. You don't need to! **We simply talk through our equations in 3 steps and you're done!**
  - In resonance reactances of the capacitor and inductor are equal $XC = XL$, this is the rule. This is due to them being out of phase, and as therefore in this condition resulting in:
  - Impedance becoming equal to resistance $Z = R$. This is impedance at its minimum.
  - Ohm's Law is $V = IZ$, chuck this up on the screen, so if impedance is at minimum, current must at maximum. Resonance is usually asking you why current is at maximum, and here it is, in 3 steps!
  - Reactances are equal, impedance is minimum, current is maximum. Done! Back it up with the equations for extra security in your answers.
- We haven't said much about DC, and the reason simply is because NZQA rarely asks you for it. All you have is internal resistance, which is just a different resistor, and Kirchoff's Laws.
- Kirchoff's Laws take a bit to get your head around, so spend some time on these and don't over think them. We recommend you bring some highlighters with you so you can keep track of which current path you're following, and in general start with the battery with the largest voltage.

HOW TO PREPARE FOR THE EXAM

- For inductors and capacitors every answer comes back to how is the inductor or capacitor affecting the circuit, so make sure you can explain what an inductor does when a switch is closed and when it is opened, and the same for capacitors.
- Use your formula sheet when answering almost every question. It is the key to the relationships between everything, so noticing what is changing where and who is affecting who is the most efficient way to answer anything thrown at you, including written answers.
- Don't overthink resonance. It shows up most years. If the word isn't actually used in the AC circuits question, chances are the idea is still being asked about, so go looking for it.
- Graphs: shape and rate of change, done.