The **topics** and **types of questions** examined in this Achievement Standard. Use this sheet to plan and organise your study so that you cover everything that is required.

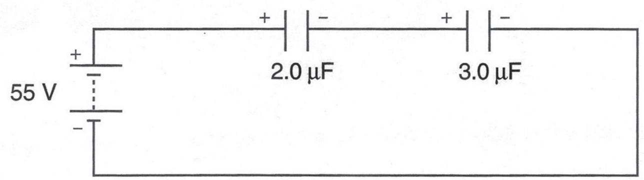
3.6 ELECTRICAL SYSTEMS AS 90523

Demonstrate understanding of electrical systems

3.6 1. DC Circuits and capacitance

- internal resistance
- simple application of Kirchhoff's Laws
- parallel plate capacitor, capacitance, dielectrics
- series and parallel capacitors
- charge / discharge characteristics of capacitors in DC RC circuits
- voltage - time and current - time graphs for a capacitor; time constant
- energy stored in a capacitor

Once in a Physics class, Petra took a 2.0 μF capacitor and a 3.0 μF capacitor and connected them in series across a 55 volt DC supply, as shown below.

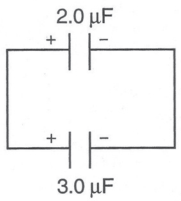


(a) Show that the total capacitance of the pair of capacitors in series is 1.2 μF.

(b) Calculate the charge on the positive plate of the 2.0 μF capacitor, when it is wired in this configuration.

(c) Calculate the voltage across the 2.0 μF capacitor, when wired in this configuration.

Petra then disconnected the capacitors from the supply and from each other and immediately reconnected them, still charged, across each other, as shown in the diagram.



(d) Calculate the charge on the positive plate of the 2.0 μF capacitor, when equilibrium is reached

3.6 2. Electromagnetic induction

- magnetic flux and magnetic flux density
- Faraday's Law and Lenz's Law
- voltage - time and current - time graphs for an inductor; time constant
- inductors, self inductance
- energy stored in an inductor
- mutual inductance and the transformer

Jess is investigating a torch to find out the characteristics of the battery and the lamp. The torch uses a filament lamp. The filament is a long coil of fine wire that heats up and glows when it carries sufficient current. For the purposes of calculation, assume that the resistance of the filament remains constant.

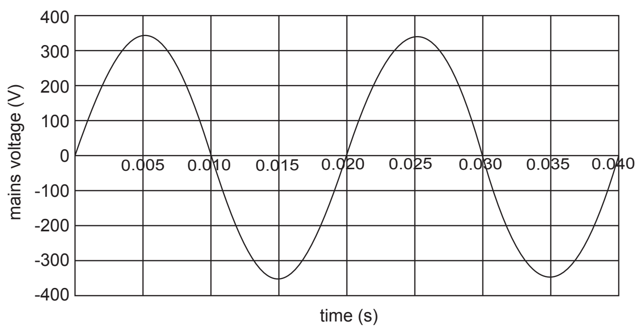
Jess suggests that it could take a few milliseconds for the lamp to reach full brightness when it is switched on, and that the lamp's filament coil could be acting as an inductor.

(a) Assuming the time constant for the filament is 1.2 ms calculate the inductance of the filament coil. Give your answer to the correct number of significant figures.

(b) Inductance can be defined from the equation $\varepsilon = -L\frac{\Delta I}{\Delta t}$

Use this definition to explain why an inductor would delay a bulb reaching full brightness after it is switched on.

The lamp is connected to an AC supply from a transformer. The supply for the transformer is a 50 Hz mains supply, with a peak voltage of 340 V. The graph below shows the variation of the mains supply with time.

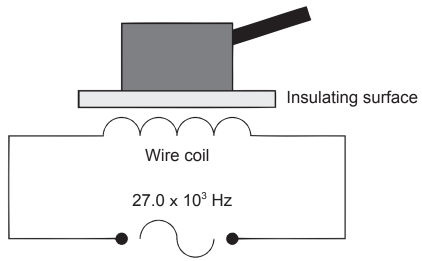


(c) Use the graph to show that the maximum rate of change of voltage in the primary coil of the transformer is approximately 100×10^3 V s^{-1}.

3.6 3. AC Circuits

- peak and rms voltage and current
- phasors in AC
- comparison of energy dissipation in a resistor carrying DC and AC
- reactance and impedence and their frequency dependence in a series circuit
- voltage and current and their phase relationship in LR and CR series circuits
- resonance in LCR circuits

Sam has an induction cooker and wants to find out how it works.



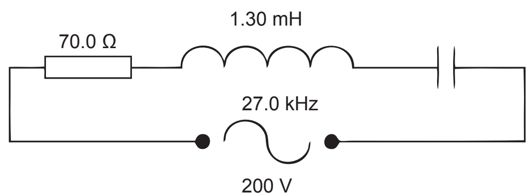
After doing some research, Sam finds that it operates by having a coil of wire underneath an insulating surface. A high frequency alternating current is passed through the coil with a frequency of 27.0×10^3 Hz.

(a) The arrangement can be used to generate heat within a metal pan placed above the coil. Explain how this occurs.

The coil used in a particular induction cooker is found to have an inductance of 1.30 mH.

(b) Show that when the frequency of the alternating current is 27.0×10^3 Hz, the reactance of the coil is 221 Ω.

In reality the inductor is part of an LCR circuit as shown below. The resistor has a resistance of 70.0 Ω and the capacitor has a reactance of 358 Ω at 27.0×10^3 Hz.



(c) Show that the capacitance of the capacitor is 1.65×10^{-8} F.