Level 3 Physics: practice paper 2026

AS 91526 Demonstrate understanding of electrical systems · Vertex Academy practice paper, not an NZQA paper

Attempt ALL the questions. Show ALL working. Write your answers on lined paper, or in the space under each question.

QUESTION ONE

(a) A 9.0 V battery with an internal resistance of 0.50 Ω is connected to a 4.0 Ω resistor.
Use $\varepsilon = I(R + r)$ and $V = IR$.
Calculate the current and the terminal voltage of the battery.

(b) The 9.0 V battery (internal resistance 0.50 Ω) delivers a current of 2.0 A.
Use $P = I^2R$.
Calculate the power wasted inside the battery, and state what happens to that energy.

(c) A car battery has an EMF of 12.6 V and an internal resistance of 0.020 Ω. When the driver starts the engine, the starter motor draws 150 A.

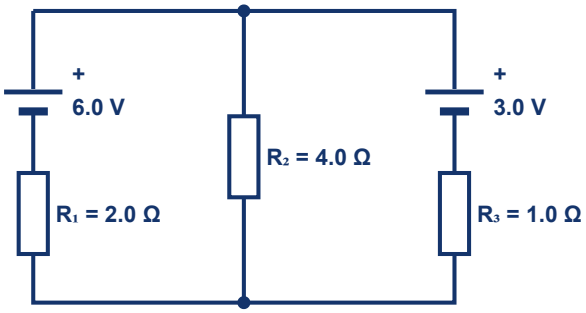
Use $V = \varepsilon - Ir$.

Calculate the battery's terminal voltage while the starter runs, and explain why the headlights dim while the engine is being started.

(d) In the circuit in the diagram, a 6.0 V cell and a 3.0 V cell (both with negligible internal resistance) are joined by three resistors: R_1 = 2.0 Ω with the 6.0 V cell, R_2 = 4.0 Ω in the middle branch, and R_3 = 1.0 Ω with the 3.0 V cell.

Use Kirchhoff's laws.

Calculate the current in R_2, and the current in the 3.0 V cell. Explain what the direction of the current in the 3.0 V cell shows.



QUESTION TWO

(a) A 470 µF capacitor in a camera flash circuit is charged to 12 V.
Use Q = CV.
Calculate the charge stored.

(b) The 470 µF capacitor holds 5.64×10^{-3} C at 12 V.
Use E = ½QV.
Calculate the energy stored.

(c) The 470 µF capacitor, charged to 12 V, discharges through a 10 kΩ resistor.
Use τ = RC and V = V_0e^(−t ÷ τ).
Calculate the time constant, the voltage after one time constant, and how long the voltage takes to fall to 3.0 V.

(d) Two square metal plates, 0.20 m by 0.20 m, are 1.0 mm apart in air. They are charged to 12 V, then disconnected from the battery. The plates are then pulled apart to 2.0 mm.

Use $C = \varepsilon_0 A \div d$ with $\varepsilon_0 = 8.85 \times 10^{-12}$ F m^{-1}, $Q = CV$ and $E = \tfrac{1}{2}CV^2$.

Calculate the capacitance and stored energy before the plates are moved. Explain what happens to the charge, the voltage and the stored energy when the plates are pulled apart, and where any extra energy comes from.

QUESTION THREE

(a) A phone charger's transformer steps 230 V mains down to 12 V. Its primary coil has 1150 turns.
Use $V_s \div V_p = N_s \div N_p$.
Calculate the number of turns on the secondary coil.

(b) New Zealand's mains supply is 230 V rms at 50 Hz.
Use $V_{max} = \sqrt{2} \times V_{rms}$.
Calculate the peak voltage of the mains, and state how many times a second it reaches that peak in each direction.

(c) An electromagnet coil has an inductance of 0.30 H. When it is switched off, the current falls from 2.0 A to zero in 0.015 s.
Use $\varepsilon = -L \, \Delta I \div \Delta t$.
Calculate the size of the EMF induced in the coil, and explain, using Lenz's law, why it can cause a spark at the switch.

(d) A 22 μF capacitor and a 120 Ω resistor are in series across the 230 V rms, 50 Hz mains.
Use $X_C = 1 \div (2\pi fC)$, $Z = \sqrt{(R^2 + X_C^2)}$, $V = IZ$ and $\tan \varphi = X_C \div R$.
Calculate the rms current and the phase angle between the current and the supply voltage, and say whether the current leads or lags. Explain what happens to the current if the supply frequency is increased.

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