AQA

A Level

A Level Physics

Electromagnetism 3

Name:

M M E

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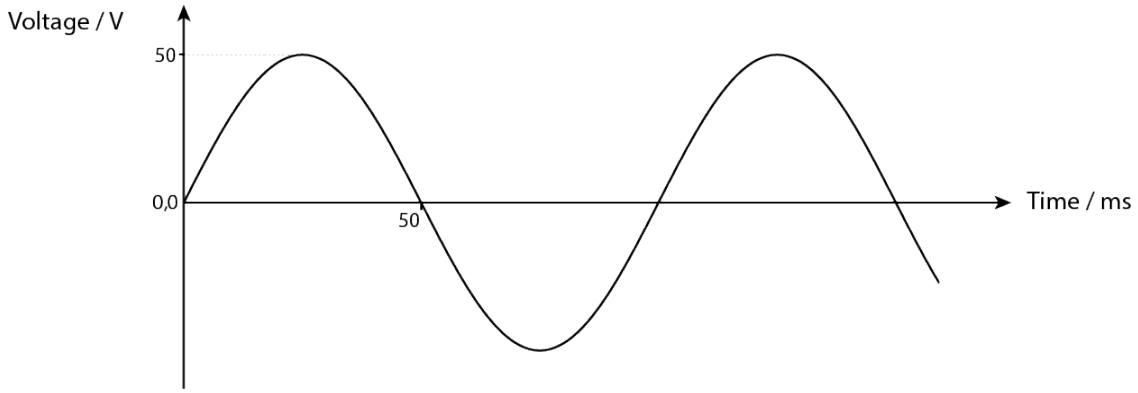
Total Marks: /30

1. The graph below shows how the voltage varies sinusoidally as a square coil is rotated in a uniform magnetic field of flux density 0.8 T. The coil measures 5 cm along each side and has 500 turns.

Total for Question 1: 17



(a) The variation of voltage with time can be modelled by the equation $V = V_{max} \sin \omega t$, where V_{max} and ω are the peak voltage and the angular frequency, respectively. By considering the power dissipated through an ohmic resistor, show that the average power dissipated is given by $\frac{V_{max}^2}{2R}$. [3]

(b) This will be the same as the power dissipated by a direct current source running through a resistor. Express V_{DC} in terms of V_{max}. [2]

(c) In the UK, the peak voltage of mains electricity is about 325 V. Why, then, is mains electricity frequently referred to as having a voltage of 230 V? Support your answer using simple calculations. [3]

(d) The AC supply above is used to power a circuit with a resistance of 40.0 Ω. Calculate the following:

i. The angular frequency of the supply. [2]

ii. The peak current in the circuit. [2]

iii. The time taken to dissipate 800 J of energy in the circuit. [2]

iv. The emf induced in the coil after 25 ms of operation. [3]

2. Power in the national grid is transmitted at very high voltages. Transformers are used to reduce the transmission voltages to safer domestic voltages. A country's national grid depends on approximately 12000 km of power transmission cables operating at about 400 kV.

Total for Question 2: 13

(a) If the secondary coil of one of the step-down transformers is to continually have a non-zero current, why must the primary coil's supply have an alternating current? [3]

(b) Why is it important that electricity is transmitted at high voltages and through cables with low resistivities? [2]

(c) Given that the current in the grid is approximately 1000 A, calculate the resistance of the network expressing your answer in units of Ω km^{-1}. [3]

(d) A typical power station provides an average of 80 MW to the grid. Calculate the power supplied by the grid, assuming that 100 stations like these feed it. [3]

(e) Using your answer to the previous part, calculate the efficiency of the grid. [2]