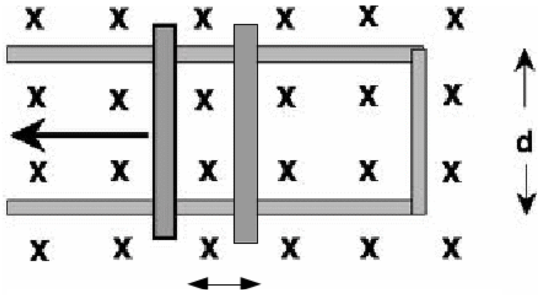
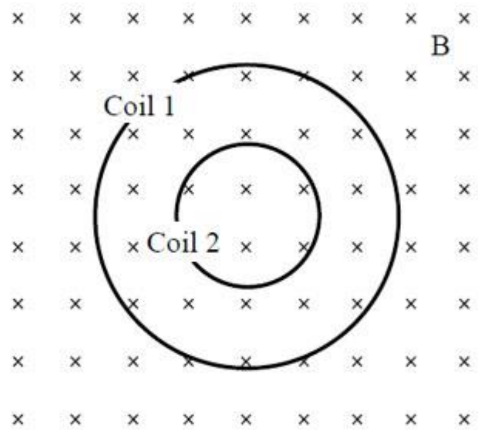
# 11 Electro-magnetic induction review questions

## Induced emf

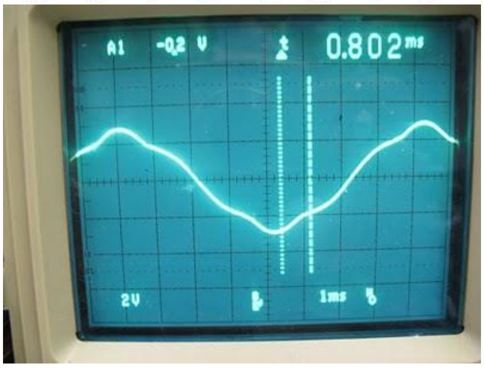



1. A wire is moved left to right through a magnetic field going into page as shown.
    a. State the direction of the induced electro-motive force.
    b. State the formula giving the size of this emf.
2. In the next diagram two coils of resistance wire of different diameters are in the same uniform magnetic field B. The magnitude of the magnetic field is increasing with time at a rate of $8Ts^{-1}$.
    a. State Lenz's law and use it to work out in which direction the current will flow.
    b. Calculate the size of the induced emf ignoring the magnetic effect of the induced current.
    c. State why the actual emf induced will be less than your answer in part b.

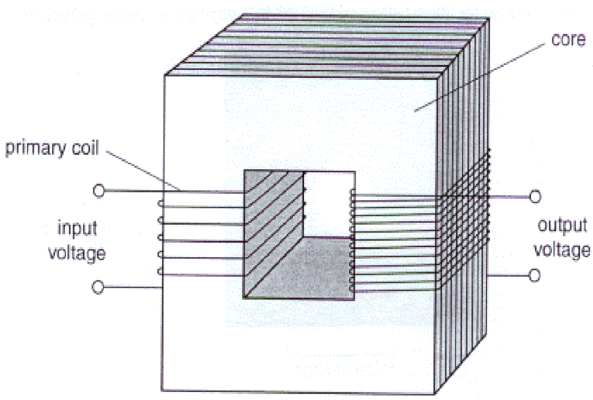


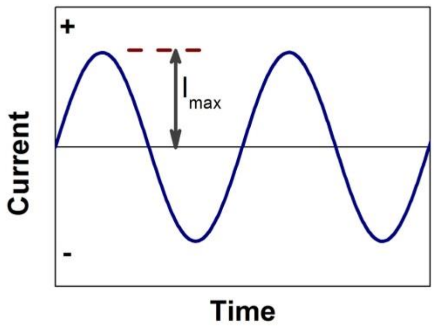

## Alternating current

The trace opposite shows the induced emf of an AC generator peaking at 0.2V with a period of 64ms for a rotation.



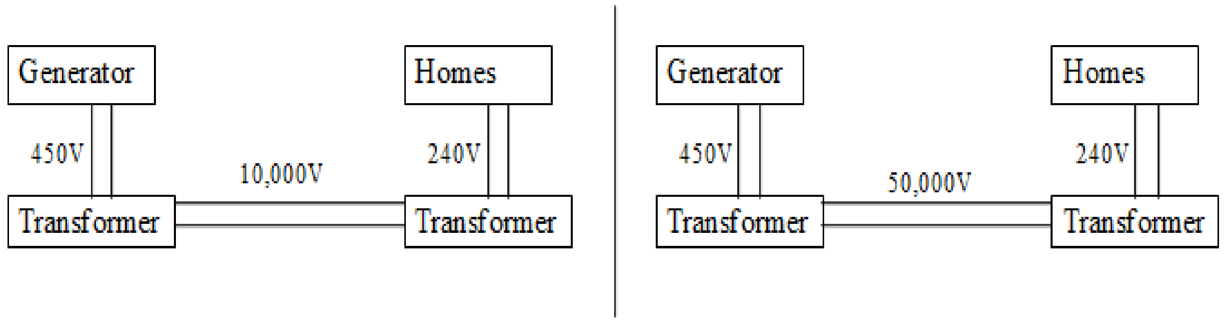

1. State the approximate rms value of the voltage.
2. Describe and quantify two differences in the trace is the generator was to rotate with a period of 32ms.
3. If the generator was connected to a 100 Ohmic resistor for this experiment calculate the power dissipated.
    a. At 64ms rotation period.
    b. At 32ms rotation period.
4. Describe how alternating current in a primary coil induces emf in a secondary coil of a transformer. State at what point in current's variation the induced voltage will be at its maximum.



## Transmission of electrical power

1. This question gets you to compare these two power transmission systems:




The high voltage transmission lines in each system have a resistance of 1 Ohm. Assume the other parts of the system have negligible energy losses. 100kW of electrical power is being transferred to the “Homes” in each system

(i) Calculate the current flowing in the 240V circuit.

(ii) Calculate the current flowing

(a) the 10,000V line

(b) the 50,000V line.

(iii) Given that the power loss is equal to $I^2R$ for any circuit component calculate the power loss for

(a) The 10,000V line

(b) The 50,000V line

(iv) What power must the generators provide (give your answers to 4 s.f)

(a) For the 10,000V line

(b) For the 50,000V line

(v) What current must the two generators produce if their output voltage is 450V?

(vi) Why are very high voltage lines used for long distance power distribution?

2. Transformers are not “perfect”. An alternating supply delivers a current of 0.025 A at 12 V to the primary coil of a transformer. A 20 Ω resistor is connected to the secondary coil. The current in the secondary circuit is 0.110 A.
    a. Calculate the power input.
    b. Calculate the power output.
    c. Calculate the efficiency.

3. For the same transformer as in question 2 the frequency of the supply is increased. The power input is kept constant. The current in the secondary coil falls to 0.105 A. Calculate the new efficiency of the transformer.

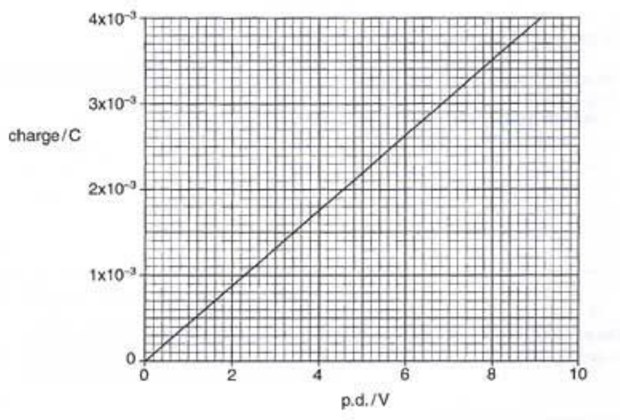
4. Outline why many people do not wish to live near to electricity sub-stations and power lines.

## Capacitance

1. Define a dielectric material and explain why they are useful in a capacitor.

2. A capacitor of coiled plates can be approximated to a parallel plate capacitor. A 16µF capacitor has a plate area of 6500 $mm^2$ and a plate separation of 0.20µm. Calculate the permittivity of the dielectric material in between the plates.

3. The graph shows the charge stored on a capacitor for varying applied potential differences:
   a. Calculate the capacitance of the capacitor
   b. Calculate the energy stored on the capacitor when a potential difference of 8V is applied across it
   c. State the effect on the energy storage if two such capacitors are connected
      i. In series
      ii. In parallel




4. The graph below shows the potential difference across a capacitor as it charges from a 9V battery via a a 14.3kΩ resistor. The potential difference on a charging capacitor at time t is: $V = V_o(1-e^{-(t/\tau)})$ where $V_o$ is the final potential difference and τ is the time constant.

   a. Using the graph show that a time constant of $10s^{-1}$ is correct for this circuit.

   Hence calculate..

   b. The capacitance of the capacitor.
   c. The final amount of charge stored.
   d. The amount of charge stored at time t=10s
   e. The final amount of energy stored.
   f. The rate of transfer of energy at t=5s