AQA Examination-style questions

1 A coil is connected to a centre zero ammeter, as shown in **Figure 1**. A student drops a magnet so that it falls vertically and completely through the coil.

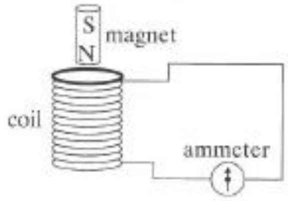


Figure 1

(a) Describe what the student would observe on the ammeter as the magnet falls through the coil. *(2 marks)*

(b) If the coil were not present the magnet would accelerate downwards at the acceleration due to gravity. State and explain how its acceleration in the student's experiment would be affected, if at all,

(i) as it entered the coil,

(ii) as it left the coil. *(4 marks)*

(c) Suppose the student forgot to connect the ammeter to the coil, therefore leaving the circuit incomplete, before carrying out the experiment. Describe and explain what difference this would make to your conclusions in part (b). *(3 marks)*

AQA, 2004

2 Faraday's law of electromagnetic induction predicts that the induced emf, E, in a coil is given by

$$\frac{\Delta(N\Phi)}{t}.$$

(a) (i) What quantity does the symbol Φ represent?

(ii) State the SI unit for Φ. *(2 marks)*

(b) In **Figure 2** the magnet forms the bob of a simple pendulum. The magnet oscillates with a small amplitude along the axis of a 240 turn coil that has a cross-sectional area of $2.5 \times 10^{-4}\,m^2$.

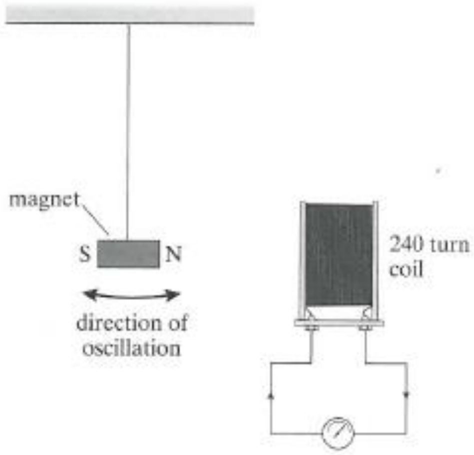


Figure 2

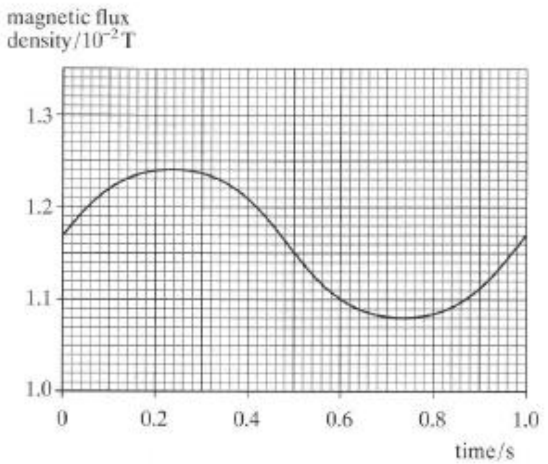


Figure 3

Figure 3 shows how the magnetic flux density, B, through the coil varies with time, t, for one complete oscillation of the magnet. The magnetic flux density through the coil can be assumed to be uniform.

(i) Calculate the maximum emf induced in the coil.

(ii) Sketch a graph to show how the induced emf in the coil varies during the same time interval.

(iii) Explain how the pendulum may be modified to double the frequency of oscillation of the magnet.

(iv) The frequency of oscillation of the magnet is increased without changing the amplitude. Explain why this increases the maximum induced emf.

(v) State **two** other ways of increasing the maximum induced emf. *(11 marks)*

AQA, 2003

3 **Figure 4** shows a system used by an engineer to determine the rate of revolution of a rotating axle.

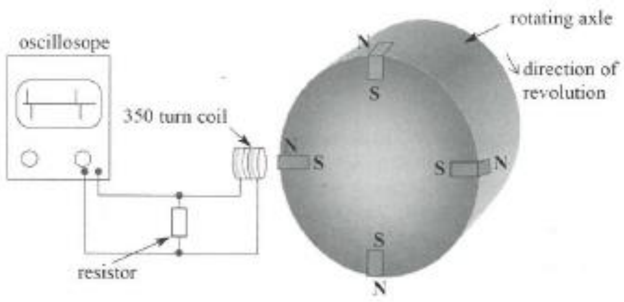
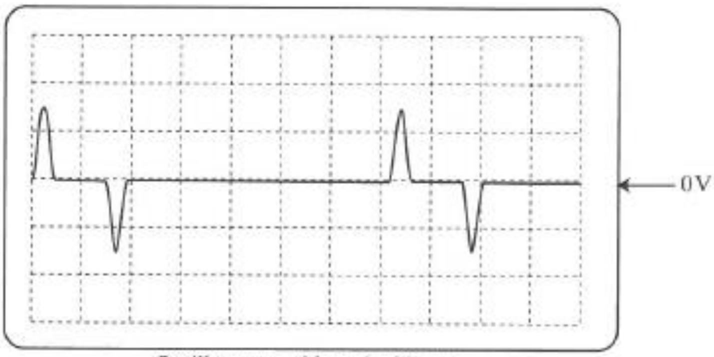


Figure 4

Four small bar magnets are embedded in the axle as shown. The N pole of each magnet is towards the outside of the axle. A voltage is produced between the terminals of a coil placed close to the rotating axle. The voltage produced is monitored using an oscilloscope. The waveform produced is shown in **Figure 5**.



Oscilloscope grid marked in cm
The Y amplifier setting = $5\,\mathrm{mV\,cm^{-1}}$
The time-base setting = $10\,\mathrm{ms\,cm^{-1}}$

Figure 5

(a) Determine the number of revolutions made by the axle in one minute. *(3 marks)*

(b) (i) Use Faraday's law to explain how the voltage pulses are produced.

(ii) The coil has 350 turns. Determine the maximum rate of change of flux through the coil. *(6 marks)*

(c) Use Lenz's law to explain the production of positive and negative voltage pulses. *(3 marks)*

(d) Draw on a copy of **Figure 5** the waveform that shows the changes you would expect to see when the rate of revolution of the axle increases. *(3 marks)*

AQA, 2007

4 (a) Copy and complete the diagram in **Figure 6** to show a current balance, which may be used to measure the magnetic flux density between the poles of the ceramic magnets. Clearly label the directions of the current and the magnetic force acting on the conductor in the field.

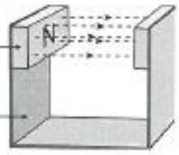


Figure 6 *(3 marks)*

(b) (i) The armature of a simple motor consists of a square coil of 20 turns and carries a current of 0.55 A just before it starts to move. The lengths of the sides of the coil are 0.15 m and they are positioned perpendicular to a magnetic field of flux density 40 mT. Calculate the force on each side of the coil.

(ii) Explain why the current falls below 0.55 A once the coil of the motor is rotating.

(iii) The resistance of the coil is $0.50\,\Omega$. When the coil is rotating at a constant rate the minimum current in the coil is found to be 0.14 A. Calculate the maximum rate at which the flux is cut by the coil. *(8 marks)*

AQA, 2003

5 (a) Explain what is meant by the term *magnetic flux linkage*. State its unit. *(2 marks)*

(b) Explain, in terms of electromagnetic induction, how a transformer may be used to step down voltage. *(4 marks)*

(c) A minidisc player is provided with a mains adapter. The adapter uses a transformer with a turns ratio of 15 : 1 to step down the mains voltage from 230 V.

(i) Calculate the output voltage of the transformer.

(ii) State **two** reasons why the transformer may be less than 100% efficient. *(4 marks)*

AQA, 2004

6 (a) A transformer, operating from 230 V, supplies a 12 V garden lighting system consisting of 8 lamps. Each lamp is rated at 30 W and they are connected in parallel.

(i) The primary coil of the transformer has 3000 turns. Calculate the number of turns on the secondary coil.

(ii) Show that the total resistance of the lamps when they are working at normal brightness is 0.60 Ω.

(iii) Calculate the power input to the transformer, assuming that the transformer is perfectly efficient. *(8 marks)*

(b) **Figure 7** shows a brass pendulum bob swinging through the magnetic field above a strong magnet. Its oscillations are observed to be quite heavily damped.

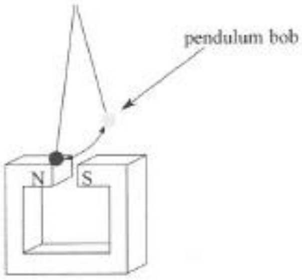


Figure 7

Explain, using the principles of electromagnetic induction, why this pendulum is heavily damped. *(4 marks)*

AQA, 2006

7 (a) Electrical power is transmitted through cables of total resistance 1.8 Ω, operated with alternating current at an rms voltage of 11 kV. The power supplied to the input of the cables is 960 kW. Calculate

(i) the peak value of the current in the cables,

(ii) the percentage of the input power that is available at the output end of the cables. *(7 marks)*

(b) When public electricity supplies were first introduced, many of the power stations generated direct current. This meant that premises that were a large distance from the power station could not be supplied economically with electricity.

Discuss this by reference to the physical principles involved, stating why ac is now preferred for distributing electrical power. *(5 marks)*