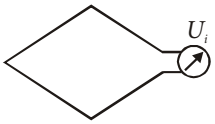
Induced EMF

Basic Problems: Homework for Tuesday, 29 August 2006

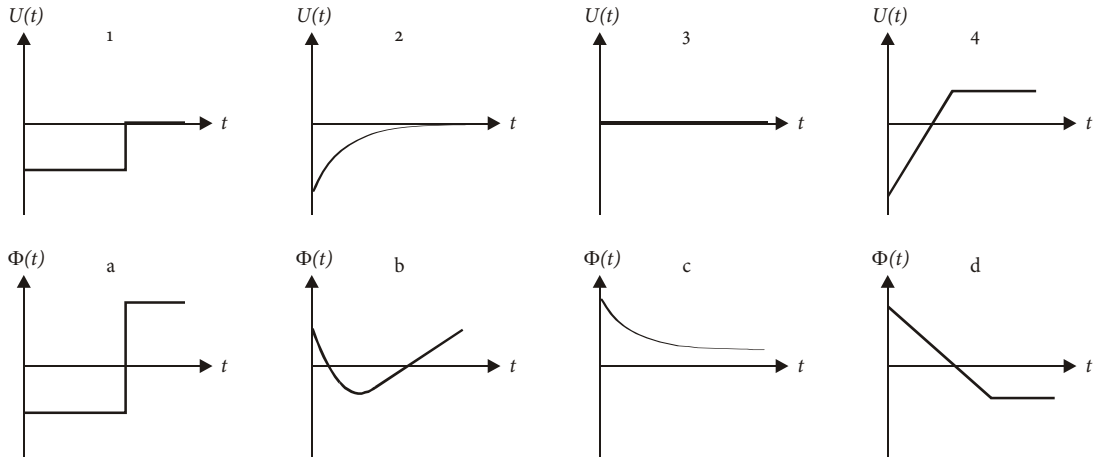
Basic Problems

1. A metal rod is dropped perpendicularly to the field lines of a magnetic field pointing to the north. Which end of the rod turns into the negative pole of the induced emf?
2. The loop of wire in the figure below has a length (from left to right) of 50 cm. It is moved to the left at constant speed through a 1 m long region with a homogeneous magnetic field perpendicular to the plane of the loop. Sketch the induced voltage in the loop vs. time until the loop has completely left the magnetic field.

   Draw the diagram for a situation where the magnetic field only covers a 25 cm long region.



3. A quadratic loop of wire with 5 cm long edges is placed perpendicularly to the field lines of a homogeneous magnetic field of magnitude 150 mT. When the loop's area is halved, an average voltage of 1.5 mV is measured between its ends. How long does the deformation take?
4. The magnetic field in a solenoid decreases from 0.3 T to 0.1 T in 3 ms. A circular loop of wire with radius 4.5 cm is placed perpendicularly to the field lines. Calculate the magnitude of the emf induced in the loop.
5. Match the induced voltage diagrams (1 to 4) and the corresponding magnetic fluxes (a to e):



Additional Problems

6. A voltmeter is connected between two rails (gauge of the track: 143.5 cm). The vertical component of the earth's magnetic field at this place has a magnitude of 43 μT.
   a) Calculate the voltage measured by the meter when a train approaches at 40 m/s.
   b) What is the reading of a voltmeter connected to one of the train's axles?
7. A semi-circular loop of wire with radius 25 cm rotates with a frequency of 0.3 Hz. During the second half of every revolution it passes through a homogeneous magnetic field with magnitude 250 mT pointing perpendicularly to the loop's plane. Draw a quantitatively correct diagram for the induced emf vs. time over two complete revolutions.
8. The 6 m long rotor blades of a helicopter turn at 9 rotations per second. At this point the vertical component of the earth's magnetic field has a magnitude of 58 μT. Calculate the induced emf between the rotor axis and the end of a blade.

Solutions to Basic Problems: 1. western end; 3. 125 ms; 4. 0.42 V; 5. 1d, 2c, 3a, 4b