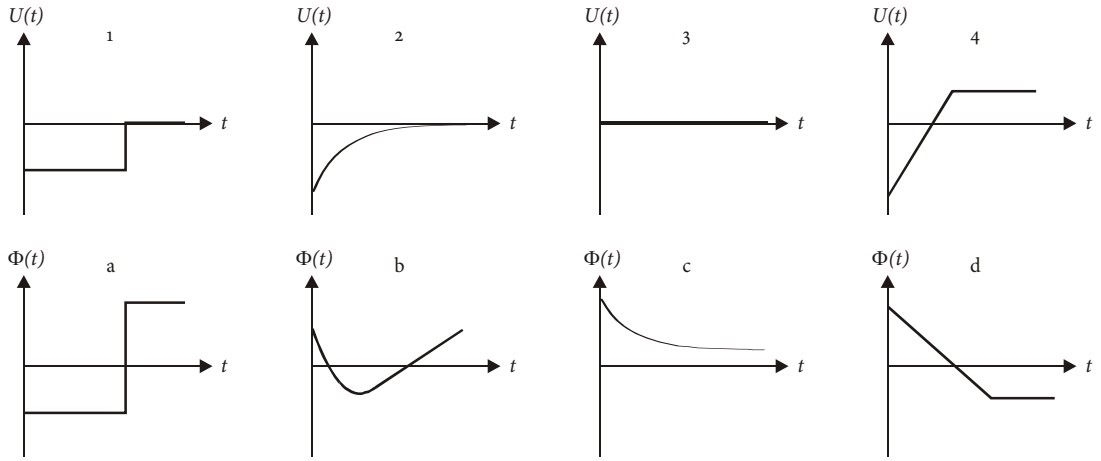
Induced EMF

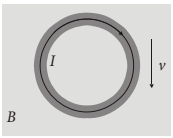
Basic Problems: Homework for Tuesday, 6 March 2007

Basic Problems

1. A train travels at 120 km/h due north. Calculate the emf induced in the axles 1.43 m long.
2. The generator in a power station produces an emf with frequency 50 Hz and amplitude 15 kV. The coil has 12 turns and an area of 8 m². Calculate the magnitude of the magnetic field flowing through the coil.
3. A square 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 d):



6. Two coils are oriented along their common axis. The first coil carries a current. Determine the direction of the current induced in the second coil (relative to the current in the first one) when the coils are moving together or apart, respectively.
7. A metal ring moves vertically through a magnetic field *B*, leading to an induced current (see figure). What can you tell about the magnetic field? Can you find more than one solution?



Additional Problems

8. 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?
9. A semi-circular loop of wire with radius 25 cm rotates with a frequency of 0.3 Hz around an axis perpendicular to the loop's plane. During the second half of every revolution it passes through a homogeneous magnetic field with magnitude 250 mT parallel to the rotational axis. Draw a quantitatively correct diagram for the induced emf vs. time over two complete revolutions.
10. A square copper frame with sides 1.2 m long and resistance 10 mΩ is moved at 2 m/s perpendicularly to the field lines of a magnetic field of magnitude 0.15 T. Calculate the force required to enter the field.

Solutions to Basic Problems: 1. 0.20 mV; 2. 0.5 T; 3. 125 ms; 4. 0.42 V; 5. 1d, 2c, 3a, 4b