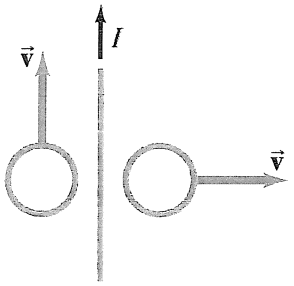
NABBEM05E.2011-2012.1A Test October 11 2012

Elektriciteit en magnetisme 2
Instructor: A.M. van den Berg
Nederlandse versie: zie pagina's 1-2

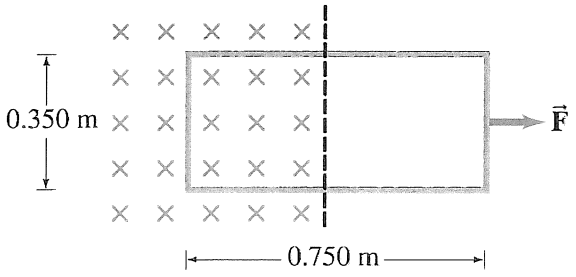
You don't have to use separate sheets for every question.
Write your name and S number on every sheet
There are **4 questions** with a total number of marks: 75

WRITE CLEARLY

(1) (Total 10 punten)
Two loops of wire are moving with a velocity $\vec{v}$ in the vicinity of a very long straight wire which carries a current I; see the figure. The loop at the left-hand side moves parallel to the wire, the one on the right-hand side moves perpendicular to the direction of the wire.
(a) (5 marks) Give the direction of the induced current in each of the loops.
(b) (5 marks) Explain your answer.



(2) (Totaal 20 marks)
A single loop with dimensions as shown in the figure is partially located in a uniform magnetic field with strength 0.65 T; the direction of the field points inside the page. The total resistance of the loop is 0.28 Ω. The loop moves with a constant velocity of 3.40 m s^{-1} to the right. Gravitational and friction forces can be neglected.
(a) (5 marks) Does the magnetic flux enclosed by the loop increase or does it decrease if one moves the loop to the right?
(b) (5 marks) Calculate the induced EMF in the loop.
(c) (5 marks) Calculate de induced current in the loop and indicate in which direction the current flows. Explain your choice.
(d) (5 marks) Calculate the force which is required to pull the loop to the right.



(3) (Total 20 marks)
A coaxial cable is made of two concentric cylindrical shaped conductors. The thickness of the wall of these conductors can be neglected. The radius of the inner conductor is r_1, the one of the outer conductor is r_2. Through these conductors runs a current I which is equal

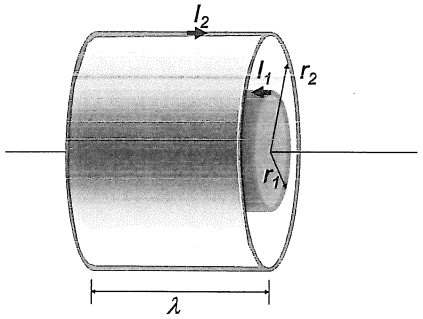
in magnitude for both conductors. The direction of the current in the outer conductor is opposite to that in the inner conductor.

(a) (5 marks) Calculate the magnetic field strength between these two conductors.

(b) (5 marks) Calculate the magnetic flux between these two conductors over a distance with length λ along the coaxial cable. Thus through an area A with dimensions: $A = [(r_2 - r_1) \cdot \lambda]$

(c) (5 marks) Calculate the inductance per unit length of this cable.

(d) (5 marks) Calculate the magnetic energy contained by the magnetic field in the region between the two conductors and over a length λ of this cable.



(4) (Total 25 marks)

A fat wire with radius a carries a constant current I, uniformly distributed over its cross section. A narrow gap in the wire, of width $w \ll a$, forms a parallel plate capacitor, as shown in the figure.

(a) (5 marks) Calculate the magnetic field strength in the gap, at a distance $s < a$.

(b) (10 marks) Assume that at time $t = 0$ the surface charges $+\sigma$ en $-\sigma$ are equal to zero. And that these charges increase constant in time; $\sigma = I\, t/\left(\pi a^2\right)$. Calculate the electric and magnetic field strengths in the gap as a function of s and of t.

(c) (10 marks) Calculate the electromagnetic energy density (energy per unit of volume) u_{EM} and the Poynting vector in the gap.