Physics Lab 206 — Mar 2016

Quiz #3 — Magnetic Force, Faraday's Law

Name:

1) Hans Christian Orsted use the same apparatus in 'Magnetic Force' lab to measure the current on a wire, i.e. use it as an ammeter as shown in fig. 1. We know the magnetic field of the magnet is $B = 0.100$ T and the length of the horizontal part of the wire is $l = 4.0$ cm.

a) Show the magnetic field direction in the front view. Use $\otimes$ or $\odot$ notation if needed. **[1 pt]** See fig. 1 (ii).

b) Draw the forces on the horizontal and vertical parts of the wire in the front view. What is the net magnetic force acting on wire? **[2 pts]** See fig. 1 (ii).

c) On the side view draw the forces acting on the magnet. **[2 pts]** See fig. 1 (i).

d) Find the current in terms of the mass, m. If the minimum mass that the scale can measure is $m_{\text{min}} = 0.01$ gr, what is the minimum current he can read, I_{min}, using this setup? **[2 pts]**

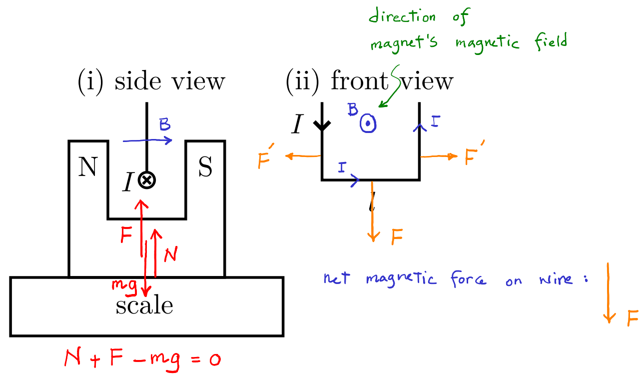

Figure 1: Ammeter, two different views, left is side view and right is front view.

$\vec{F} = \vec{I}\,l \times \vec{B} \rightarrow F = |\vec{F}| = |\vec{I}\,l \times \vec{B}| = I l B \sin 90^\circ = I l B$

$\rightarrow I = \dfrac{F}{l B} \rightarrow$ If $F_{min} = m_{min}\, g = 0.01 \times 10^{-3} \times 9.8$ N $= 1 \times 10^{-4}$ N

min. force that scale measures

$\rightarrow I_{min} = \dfrac{F_{min}}{l B} = \dfrac{1 \times 10^{-4}}{4.0 \times 10^{-2} \times 0.100} \dfrac{\text{N}}{\text{Tm}} = 3 \times 10^{-2}$ A.

precision of the ammeter made by above setup

2) Joseph Henry uses the same apparatus in the 'Faraday's Law' lab, he chooses the function generator to give us triangular magnetic flux waveform, given in the fig. 2.
The amplitude of the magnetic field waveform where the inner coil is placed, is $B_0 = 20$ mT. The area of the inner coil is $A = 4.0$ cm^2 and number of turns in this coil is $N = 11$. $\theta = 60°$, the angle between the magnetic field and the area vector.

a) Find the amplitude of the total magnetic flux passing through the inner coil, Φ_0. **[2 pts]**

b) Draw the induced emf waveform, $\mathcal{E}(t)$, on the same graph. **[2 pts]** See fig. 2.

c) Find the amplitude of the induced emf, $\mathcal{E}_0$. **[2 pts]**

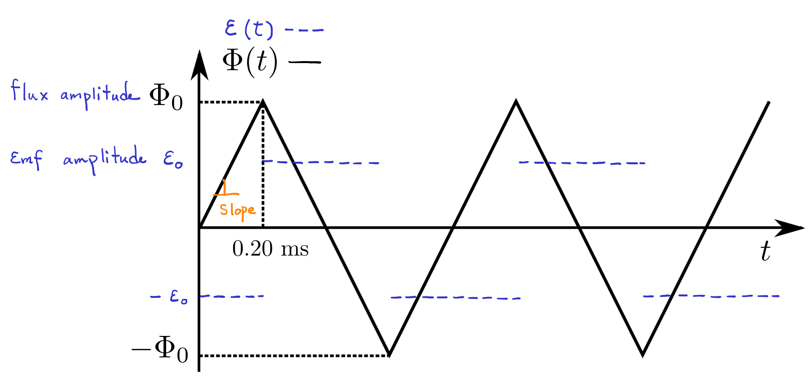

Figure 2: Flux waveform.

a) $\vec{\Phi}(t) = \vec{B}(t) \cdot \vec{A} = B(t)\, A \cos\theta$

$\rightarrow \Phi_0 = B_0 A \cos\theta$

$= 20 \times 10^{-3}$ T 4.0×10^{-4} m^2 $\cos 60^\circ = 4.0$ μWb.

c) $\mathcal{E}(t) = -N \dfrac{d\Phi(t)}{dt}$

$\rightarrow \mathcal{E}_0 = |11 \times \text{slope}|$

$= 22$ mV.

Slope $= \dfrac{\Phi_0}{0.20 \text{ ms}} = 20$ mV.

usually we use positive number for amplitude.