Magnetic Quiz – Answers for Part 1

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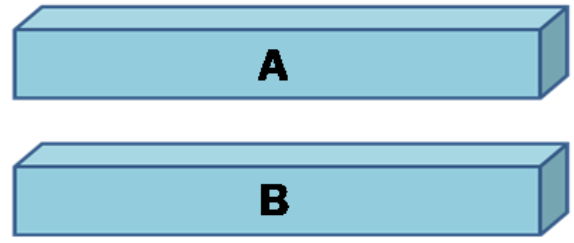
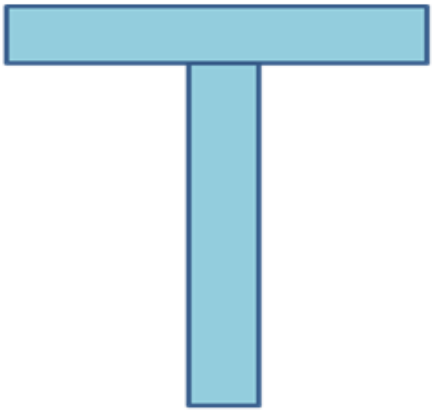
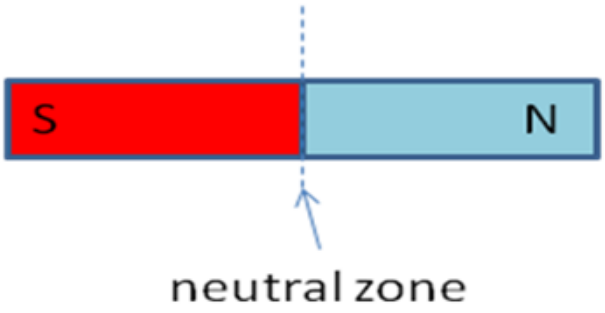
Please answer the following questions, and then send your answers directly to Vitalii. The best answer, received by midnight (Copenhagen time) on May 24, will receive a very magnetic and useful prize. It will be announced at Magmeet 2018 (http://magneticmicrosphere.com/meeting-twelfth). So don't hesitate, test your magnetic knowledge and try to answer all the following questions!

1. You have two identical looking ferromagnetic strips. Strip A is magnetized, while strip B is not. Without using any additional instruments, it is possible to determine which of the two strips is the magnet. Describe how you would do it.



One should put these stripes as shown in the figure below. If them attract each other, the magnetized stripe is vertical one. To understand this answer one should know that a permanent magnet has a so-called neutral zone (near the middle plane between the magnet poles) which does not attract a ferromagnet.





2. Your mechanical watch appears to have become magnetized in your lab.

A) Will this watch go faster or slower? Explain why.

B) Also, how can you demagnetize your watch? Give at least 3 methods.

A magnetized mechanical watch will go slowly. Indeed, the watch pendulum will rotate in the presence of the magnetic field created by the magnetized surrounding mechanism. In accord with Faraday's and Lenz's laws the pendulum rotation will be dumped because of the current induced in it. Reminding: An induced current is always in such a direction as to oppose the motion or change causing it.

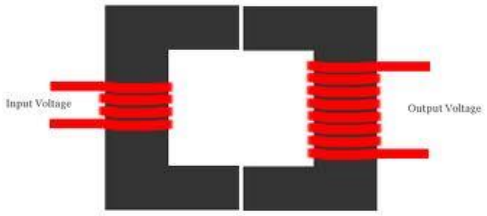
There are really three ways to demagnetize the watch. The first, by applying magnetic ac-field with decaying amplitude. The second, to increase temperature of the watch above the Curie point; Tc=1043 K for Iron (we do not recommend it ☺). Third, to use the relation between the spin and magnetic moments of electron, i.e. to hit the watch or to intensively shake it (do not apply this for your watch ☺).

watch pendulum

3. Your working transformer makes an unpleasant buzzing sound.

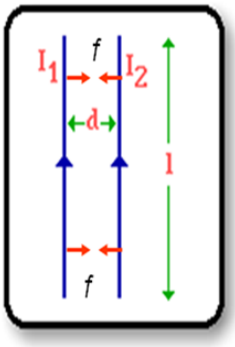
A) What is the reason for this sound?

B) And can you tell what the frequency of its sound is?



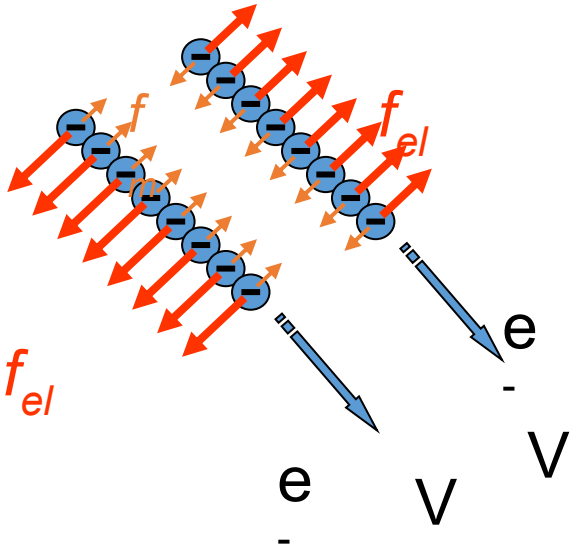
A working transformer produces sound of the frequency which is two times larger than the frequency of input voltage. The explanation is the following. Transformers are constrained in their performance by the magnetic flux limitations of the core. The core consists of the soft ferromagnetic thin slabs. In the presence of an ac-magnetic field produced by current these slab start to be magnetized along the field. But during the period the field changes its direction two times (imagine one period of a sinusoidal function). So, within each period two times the slabs are magnetized parallel and repulse each other and therefore become be bent. Also within each period they are not magnetized when ac- magnetic field is zero. At these moments the slabs do not interact and are parallel. So, mechanical oscillations of the slabs appear due to their magnetization by flowing ac-current. During one period of the current change the slabs have parallel magnetization two times (up and down). This is the reason for the appearance of sound with doubled frequency.

4. Two parallel currents attract each other with the force, *f* (see figure to the right). But two parallel beams of electrons repulse each other. What are the reasons?



$$f = \frac{F_A}{l} = k\frac{I_1 I_2}{d}$$

Current in a conductor is an electrons' flow in the positive charge envelope (e.g. atomic lattice). So, electrical repulsion is screened: $f_m >> f_{el}$. See the picture below.

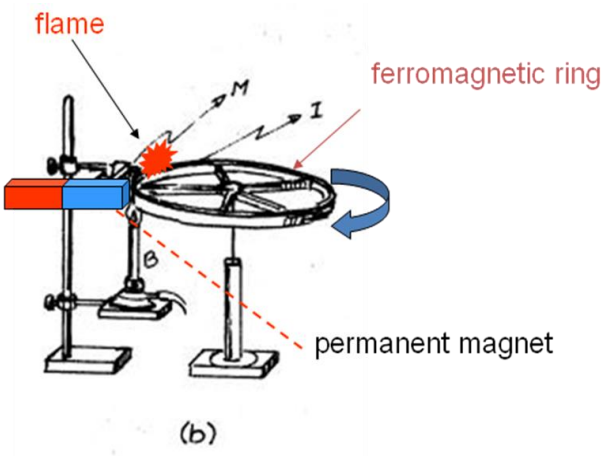


5. A thermo-magnetic motor, suggested by Stephan more than 100 years ago, is shown in the figure to the right.

A) How is it possible that this device rotates and produces mechanical work?

B) How could you increase the efficiency coefficient of this engine?

C) Will the ring turn a) clockwise (as indicated in the graph) or b) counter clockwise?



When the ring is heated with a flame, its ferromagnetic property is lost when the temperature exceeds the Curie temperature. The magnet no longer attracts the ring part with T>Tc. The ferromagnetic property is restored and is attracted back into the magnet (M). The cycle repeats. To increase the efficiency coefficient of this engine one should choose low Tc-material. The ring will turn to left (clockwise).