

Tools for Materials Science - Challenge n°6 - 40'

SEEING MAGNETIC FIELD

- On the desk you have a green plastic sheet.
 Q1. What kind of material is this plastic sheet and which are its properties?
- 2. Take two of your smartphones (possibly different ones) and in each of them locate the inside magnet/s using the viewing film.

Q2. Are the magnets in specific positions? Which functionality of the smartphone is located in that spot?

CAUTION! In the following STRONG MAGNETIC FIELD: keep the magnets FAR from any:

- -> <u>magnetic memory</u> (inside PC, smartphone, any other electronic device)
- -> magnetic card
- -> pace maker or any similar health-care device.
- 3. Now you will explore several magnets of different shape and/or configurations using both the green viewing sheet and iron filings. Proceed as follows for each configuration:
 - A. Take a photo of the initial magnets configuration.
 - B. Put the plastic box with iron filings inside near/over the magnets configuration: you will see the filings rotate and adjust themselves reorienting along the magnetic field lines in 3D. Take a photo
 - C. Put the green sheet on a similar configuration and compare the effect (2D) with B. Take a photo.

Q3. For each configuration describe and explain what you are seeing making connexions between the two ways of magnetic field visualization.

4. In spite of your observations you may still not know how the sheet is really made and works. So the first step is to observe it under a microscope. You may want to use your smartphone lens magnifier app and - if this is not powerful enough - a portable microscope (to use together with your smartphone camera or even the smartphone magnifier lens) or even a USB microscope connected to the PC.

[*N.B.* Better to observe the sheet from the opaque side, not the shining one where stronger reflections may be an obstacle to a clear view, particularly with the USB microscope.]

Why is the plastic turning from dark to whitish? Actually embedded in the sheet there are lots of tiny capsules filled with oil in which extremely tiny metal particles/needles are floating and free to move steering their orientation under the influence of the surrounding magnetic field. The small plates always turn around in order to be parallel to the magnetic field lines. When they are also parallel to the plane of the sheet then you see "whitish " clear streaks because light is strongly reflected back, while when the plates are perpendicular to the plane of the sheet then the sheet looks dark since almost no light is being reflected back.

Q4. Try to move a magnet under the sheet while still under the microscope/camera. What do you observe? Explore and make a video (best option) or photos to back this piece of information.

OUTPUT WANTED :

- -> Answer to Q1, Q2;
- -> Pictures and descriptions and explanations for Q3 [at least 3 magnets shape/configuration]
- -> Q4 + pictures or video (most meaningful and beautiful)



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Answer sheet

GROUP N°_____

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Ch.6 --- SEEING MAGNETIC FIELD

<u>Q1</u>

<u>Q2</u>

<u>Q3</u> for each different magnet shape and/or configuration (at least 3)

<u>PICTURES</u> [Sent by Whatsapp to your group – See general instruction to share pictures or files]

• Configuration 1 - description and explanation:

• Configuration 2 - description and explanation:

• Configuration 3 - description and explanation:

<u>Q4:</u>

<u>PICTURES/VIDEO</u> [Sent by Whatsapp to your group – See general instruction to share pictures or files]

ANSWER: description and explanation

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Teacher's notes

Technical notes:

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Organizational notes:

• Each student will keep a copy of the students' sheet but the group will collectively fill in the answer sheet and give it over to the teacher in charge at the end of the lab.

Correction grid

Question or	Note	Max. score
Request		
Q1		2
Q2		2
Q3:	For each different configuration:	4x3=12
Answer	Description end explanation	2
Pictures*	Meaningful (Yes/No: 1 point); beautiful (Yes/No: 1 point)*	2
Q4 – answer	Description end explanation	2
Q4 – pictures	Meaningful (Yes/No: 1 point); beautiful (Yes/No: 1 point)*	2

*Pictures: are the pictures meaningful? [*To evaluate the "meaningful" see also the "Picture Description" on the Answer Sheet*] Are they focusing on significant details or clearly showing the apparatus structure or the investigation results? Are they aesthetically beautiful?

Key to Answer

Q1. For magnetic film viewing

Q2. At least one magnet near the microphone is present in each smartphone

Q3. Possible configuration of magnets:

- Bar magnets
- Horse shoe magnet
- Neodymium cylindrical magnet
- Pile of neodymium cylindrical magnets
- Ring neodymium magnets
- Column of ring neodymium magnets
- Ring made of several magnetic spheres
- Square quadrupole magnets used in the levitation set
- Fridge magnets
- Magnetic paper

Q4. Under the microscope the spherical capsules can be clearly seen (fig.1) together with the aligned ones (white) along one of the line fields (see fig. 2 the row of small white spheres)

MoM Resources (http://www.mattersofmatter.eu/mom-materials/)

• **Ch7_TEACH_EN_Eddy current brakes** –In this activity the magnetiv viewing film is used to study the effect of Eddy currents on a magnet falling inside both copper and clear plastic tubes

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Fig 1 Magnetic Field Viewing Film under USB microscope.Left: the line of white alianed spheres is clearly visible



Fig 2 Magnetic Field Viewing Film under the plexiglass DIY microscope-From Left to right: The embedded microspheres are clearly visible. They show no particular configuration when there's no magnetif field nearby, when a cilindrical magnet is set nearbyr the alignement is in circles following the magnetic field lines

Above:Using a cylindrical magnet with the base parallel to the sheet plane the circular alignment of the capsules can be clearly appreciated (fig. 3 and 4) and you actually can shoot a video showing the capsules moving along with the movement of the magnet. **Below:** using the magnetic field viewer to "see" how a fridg



magnet is structured .Right: how it appears under the microscope



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