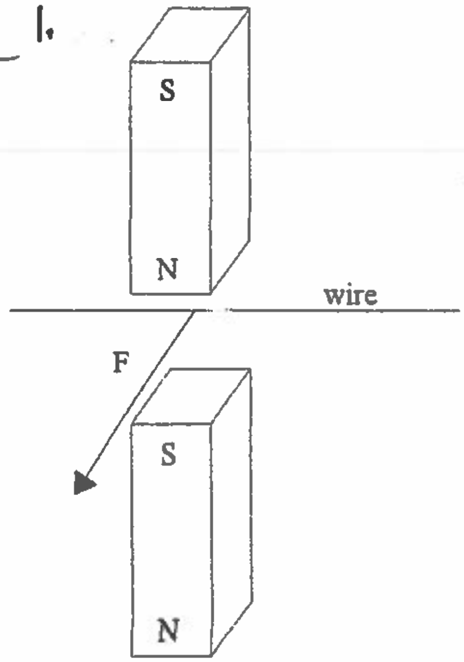
PHYSICS 12

ELECTROMAGNETISM

1.In the 6 diagrams below, clearly identify the direction of the magnetic field, electric current and force if they are not given.

1.



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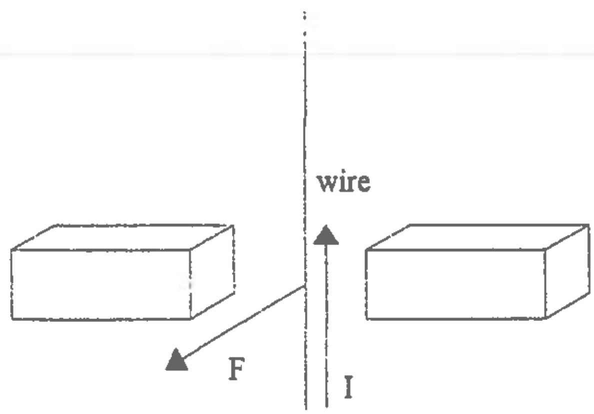

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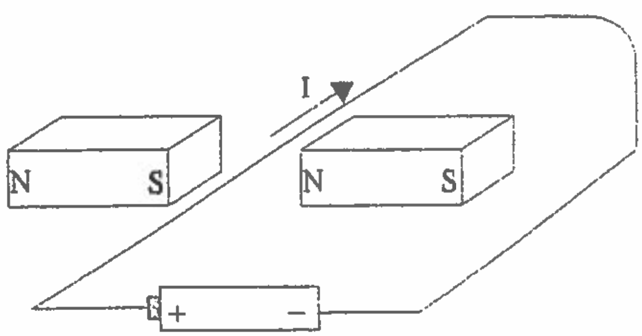

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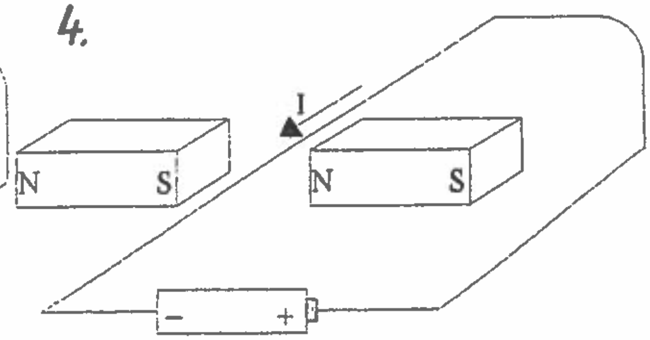

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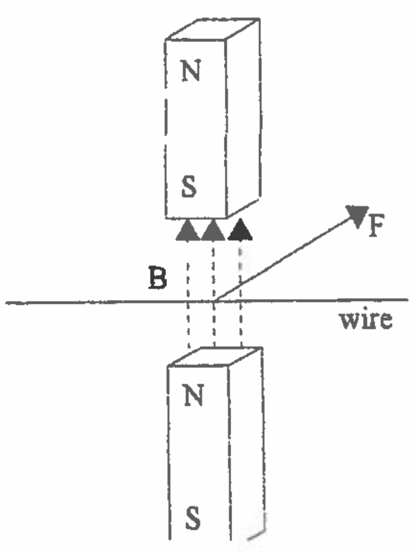

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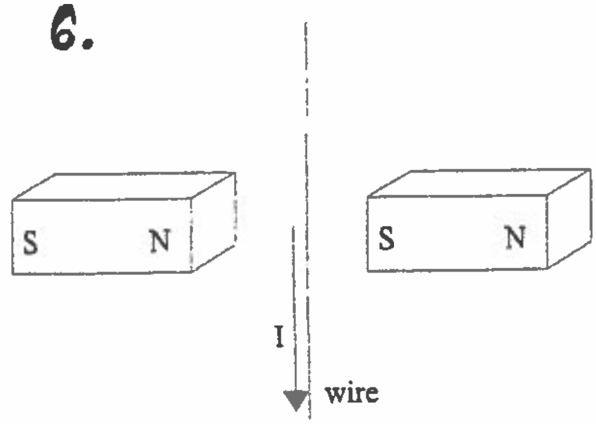
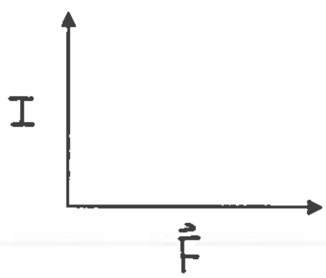


2. Indicate the direction of the missing vector quantity (use either the first or the second right-hand rule):

a)



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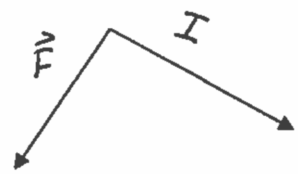
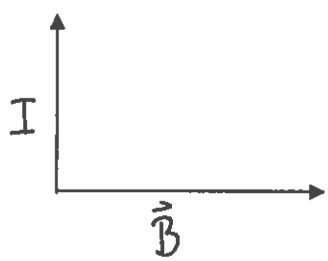
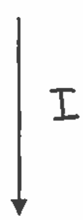


c)

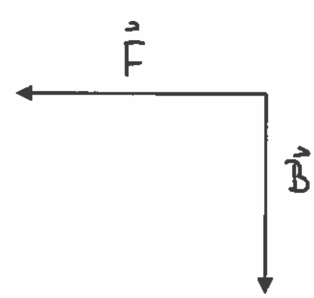


d)

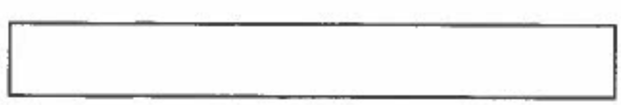
e)



f)



3. Draw the magnetic field lines around a bar magnet and clearly identify direction and label the poles.



RELATIONSHIP BETWEEN FORCE, EL. CURENT AND MAGNETIC FIELD

The force on a wire carrying electric current is proportional to:

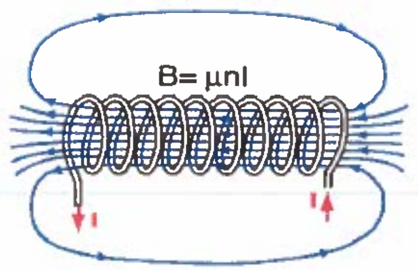
- ______________________________________
- ______________________________________
- ______________________________________

- **1 Tesla** is the strength of a magnetic field that will exert force of exactly 1 Newton on 1 meter of a wire carrying electric current of 1 Ampere.

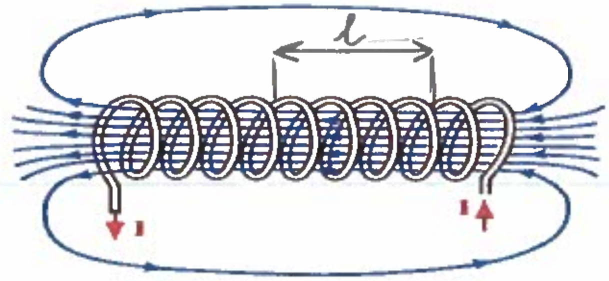
- Another unit of magnetic field is ________________________ [G] where 1 G = ____________
- The strength of the Earth's magnetic field is 0.5 G which is _____________________ T

SOLENOIDS

A solenoid is a coil of wire with many loops. The coil behaves like a permanent magnet with a North and South poles whenever the wire carries electric current.



The magnetic field is concentrated into a nearly uniform field in the center of a long solenoid. The field outside is weak and divergent.



- The strength of the magnetic field inside the solenoid is almost uniform and it is given by the following relationship:

Where _____ is the number of coils per unit length

_____ is the unit length in meters

_____ is the electric current in Amperes

_____ is **permeability of free space**

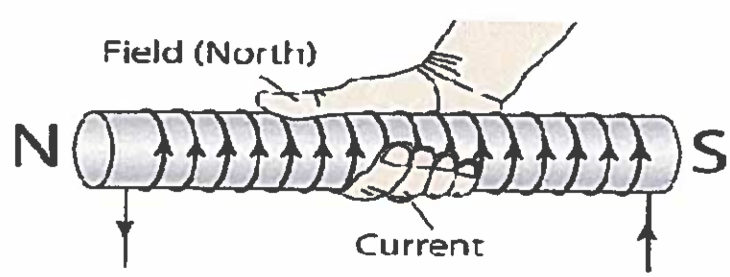
$$\mu_0 = 4\pi \times 10^{-7}\ \text{Tm/A}$$

Alternative formula:

Where n is the number of loops and l is the length of the solenoid.

- Permeability is a measure of a material's ability to support magnetic field. Often solenoids have iron cores to increase the strength of the magnetic field. The permeability of Fe is about 5000 times greater that the permeability of free space.

Right-Hand Rule #3

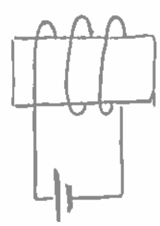


Solenoid	Strength of the magnetic field
Coil diameter decreases	
Number of turns in a coil increases	
Current increases	
Ferromagnetic material with high μ is added	

Practice

Indicate the direction of the magnetic field and electric current

1.



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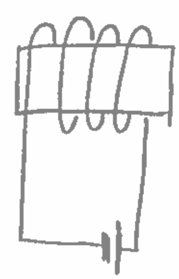

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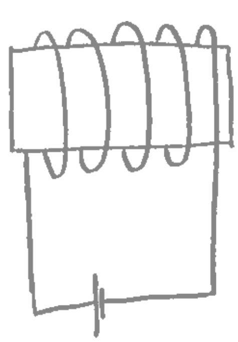

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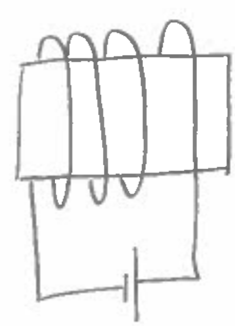
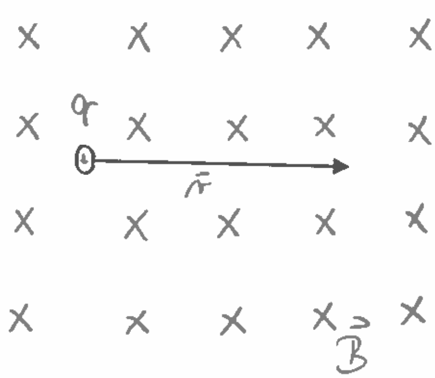


FORCE ON A CHARGED PARTICLE MOVING THROUGH A MAGNETIC FIELD

- If a charged particle moves in a magnetic field it experiences a force
  - this force is perpendicular to both, the magnetic field and the velocity.
  - Direction of the force can be found using Right-Hand Rule #4
  - The force is also dependent on the angle between the velocity and the magnetic field.
  - Maximum force is reached when the velocity and magnetic field are perpendicular.
  - Zero force is experienced when the velocity is parallel with the magnetic field.

Where θ is the angle between the **v** and **B**

Example 1 : A particle with charge of 12μC moves with velocity 2.0x10[illegible] m/s through a magnetic field of 0.75 T as shown below. Find the magnitude and direction of the force experienced by the particle.

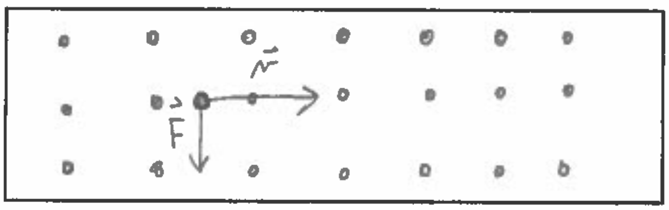


<u>Right-Hand Rule #4</u> Different for a positive and a negative particle

Example 2: Find the force (magnitude and direction) a particle with – 20μC would experience in the same magnetic as in the example 1 moving to the left with 3.0×10^6 m/s. **Sketch a diagram.**

MOTION OF A PARTICLE IN A MAGNETIC FIELD

Consider a positive charge moving in a magnetic field directed out of the page.



- As the charged particle moves through the magnetic field the force acting on the particle is down and perpendicular to the velocity
- Because the force is perpendicular to the velocity, it does not change the magnitude of the velocity but it changes its **DIRECTION**

➢ Any force that is always perpendicular to the velocity will produce circular motion = centripetal force