5.29

The formula from Griffiths for a magnetic dipole at the origin is:

$$\vec{\mathbf{A}}(\vec{r}) = \frac{\mu_0}{4\pi}\frac{\vec{m}\times\hat{r}}{r^2}$$

Is this the *exact* vector potential for a flat ring of current with **m**=I**a**, or is it approximate?

A) It's exact

B) It's exact if |r| > radius of the ring

C) It's approximate, valid for large r

D) It's approximate, valid for small r

5.30

The leading term in the vector potential multipole expansion involves $\oint d\vec{\mathbf{l}}'$

What is the magnitude of this integral?

A) R

B) 2 π R

C) 0

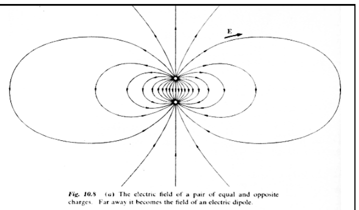
D) Something entirely different/it depends!

This is the formula for an ideal magnetic dipole:

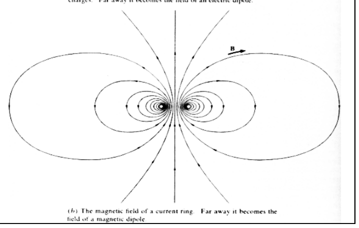
$$\vec{\mathbf{B}} = \frac{c}{r^3}(2\cos\theta\,\hat{r} + \sin\theta\,\hat{\theta})$$

What is different in a sketch of a *real* (physical) magnetic dipole (like, a small current loop)?

E-field around electric dipole



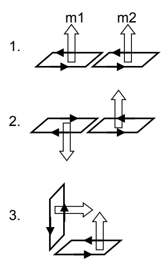
B-field around magnetic dipole (current loop)



From Purcell, Electricity and Magnetism

MD12-5

Two magnetic dipoles **m**1 and **m**2 (equal in magnitude) are oriented in three different ways.



Which ways produce a dipole field at large distances?

A) None of these
B) All three
C) 1 only
D) 1 and 2 only
E) 1 and 3 only

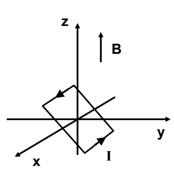
MD12-7

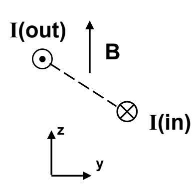
The force on a segment of wire L is $\vec{F} = I\,\vec{L}\times\vec{B}$

A current-carrying wire loop is in a constant magnetic field **B** = B **z_hat** as shown.

What is the direction of the torque on the loop?

A) Zero B) +x C) +y D) +z
E) None of these



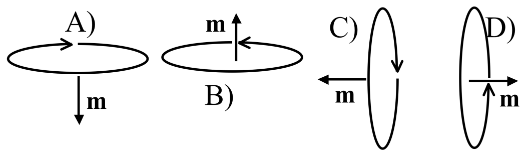


6.1

Griffiths argues that the torque *on* a magnetic dipole in a B field is:

$$\vec{\tau} = \vec{\mathbf{m}} \times \vec{\mathbf{B}}$$

How will a small current loop line up if the B field points uniformly up the page?



6.2

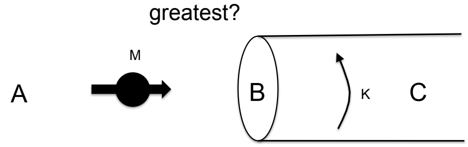
Griffiths argues that the force *on* a magnetic dipole in a B field is: $\vec{\mathbf{F}} = \vec{\nabla}(\vec{\mathbf{m}} \bullet \vec{\mathbf{B}})$

If the dipole **m** points in the z direction, what can you say about **B** if I tell you the force is in the x direction?

A) **B** simply points in the x direction
B) Bz must depend on x
C) Bz must depend on z
D) Bx must depend on x
E) Bx must depend on z

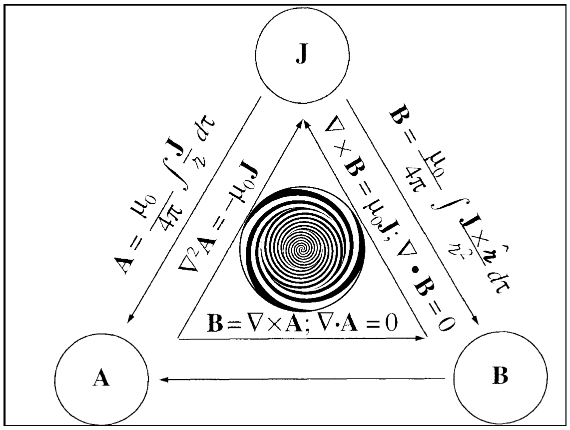
6.2x

Suppose I place a small dipole M at various locations near the end of a large solenoid. At which point is the magnitude of the force on the dipole greatest?



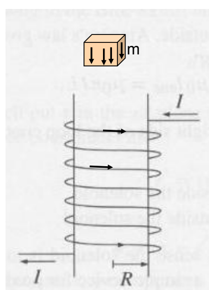
D) Not enough information to answer
E) There is no net force on a dipole

$$\vec{\mathbf{F}} = \vec{\nabla}(\vec{\mathbf{m}} \bullet \vec{\mathbf{B}})$$



6.7a A small chunk of material (the "tan cube") is placed above a solenoid. It magnetizes, weakly, as shown by small arrows inside. What kind of material must the cube be?

A) Dielectric
B) Conductor
C) Diamagnetic
D) Paramagnetic
E) Ferromagnetic



6.7b Predict the results of the following experiment: a paramagnetic bar and a diamagnetic bar are pushed inside of a solenoid.

a) The paramagnet is pushed out, the diamagnet is sucked in
b) The diamagnet is pushed out, the paramagnet is sucked in
c) Both are sucked in, but with different force
d) Both are pushed out, but with different force

ERK6.1

Which type of magnetic material has the following properties:

1) The atoms of the material have an odd number of electrons
2) The induced atomic magnetic dipoles align in the same direction as an applied magnetic field
3) Thermal energy tends to randomize the induced dipoles

A. Ferromagnetic
B. Diamagnetic
C. Paramagnetic

6.4

A solid cylinder has uniform magnetization **M** throughout the volume in the x direction as shown. What's the magnitude of the total magnetic dipole moment of the cylinder?

A) $\pi R^2 L M$
B) $2\pi R L M$
C) $2\pi R M$
Δ) $\pi R^2 M$
E) Something else, it's more complicated