Q.1:

Consider the very long (ideally infinitely long) solenoid shown in Figure Q1 . If r is the radius of the core and ℓ is the length of the solenoid, then $\ell >> r$. The total number of turns is N and the number of turns per unit length is $n = N/\ell$. The current through the coil wires is I. $B \approx \mu_o \mu_r n I$

show that the inductance is

$$L \approx \mu_o \mu_r n^2 V_{\text{core}} \qquad \textit{Inductance of long solenoid}$$

where V_{core} is the volume of the core. How would you increase the inductance of a long solenoid?

What is the approximate inductance of an air-cored solenoid with a diameter of 1 cm, length of 20 cm, and 500 turns? What is the magnetic field inside the solenoid when the current is 1 A? What happens to these values if the core medium has a relative permeability μ_r of 600?

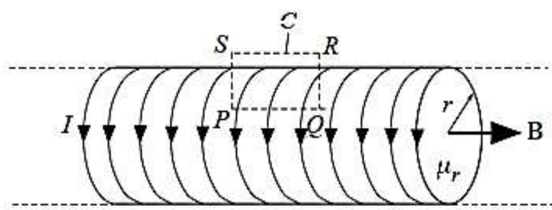

Figure Q1

Q.2:

Consider a long solenoid with a core that is an iron alloy .

Suppose that the diameter of the solenoid is 2 cm and the length of the solenoid is 20 cm. The number of turns on the solenoid is 200. The current is increased until the core is magnetized to saturation at about $I = 2$ A and the saturated magnetic field is 1.5 T.

a. What is the magnetic field intensity at the center of the solenoid and the applied magnetic field, $\mu_o H$, for saturation?

Suppose the applied magnetic field is the magnetic field in the absence of material.

b. What is the saturation magnetization M_{sat} of this iron alloy?

c. What is the total magnetization current on the surface of the magnetized iron alloy specimen?

d. If we were to remove the iron-alloy core and attempt to obtain the same magnetic field of 1.5 T inside the solenoid, how much current would we need? Is there a practical way of doing this?