	Physics 220: Untest #2	Name: ______________________

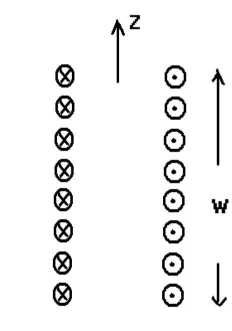
Instructions: Answer (completely and correctly) each of the following questions, using diagrams as necessary. You have 55 minutes to complete this test.

Do not discuss any aspect of this test with anyone until after the graded tests have been handed back.

$$\mu_0 = 4\pi x10^{-7}\,\tfrac{Tm}{A}; \varepsilon_0 = 8.85x10^{-12}\,\tfrac{C^2}{Nm^2}$$

(1) A solenoid has a total length w and has a total of N turns. Suppose the windings are as shown in the image below. You may ignore the end-effects and assume a perfect solenoid.
The current I is injected into the bottom of the coil and winds around to the top of the coil. The coil has a cross sectional area A. In cross section, the solenoid looks like the image show to the right.

(a) Showing details, using words and equations, obtain the magnetic field near the center of the solenoid in terms of I, n (=N/W) and a constant.

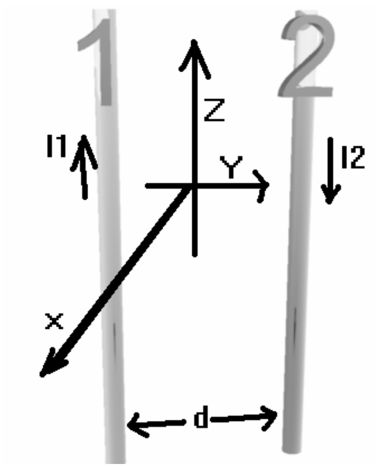


(b) Showing details, calculate the inductance of the solenoid in terms of a constant, n and the volume of the solenoid (AW).

(c) Find the magnetic energy density of the solenoid and the total magnetic energy of the solenoid.

(d) If N=1000, W=0.1m, I=10A and A=0.5m^2, provide numerical answers to a,b,c above with correct SI units.

(2) Two long wires are parallel and separated by a distance of 0.5 m. Each wire carries a current flowing in the direction as shown. Express your directions in terms of the unit vectors $\hat{x}, \hat{y}, \hat{z}$. The positive x direction is out of the page.

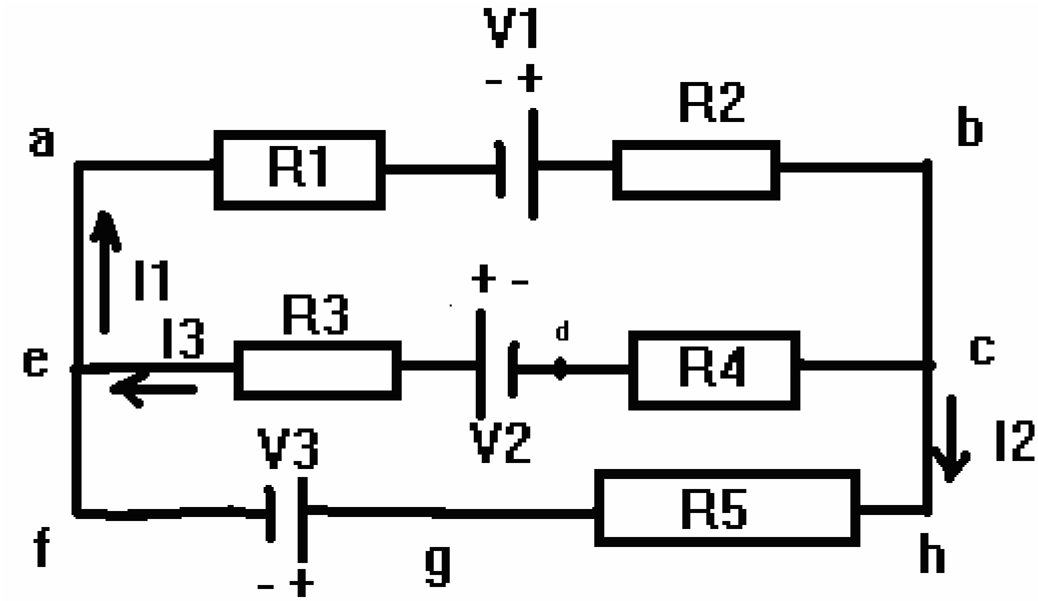


(a) What is the magnetic field (**direction and magnitude**) at wire 2 due to wire 1 in terms of a constant, d and I1?

(b) What is the **direction and magnitude** of the force on wire 2 due to wire 1 in terms of a constant, I1, I2, d and L2 (the length of wire 2)?

(c) What is the **direction and magnitude** of the magnetic field at a point ½ way between the two wires?

(d) Suppose I1=1A and I2=4A and L1=L2=10m. Provide numerical answers for (a), (b) and (c) together with correct SI units and unit vectors.



(3) Consider the circuit shown above. Write down Kirchoff's laws for:
(a) loop (abcdea):

(b) loop (echge):

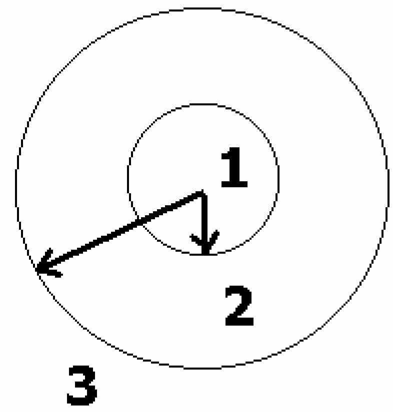
(d) junction (c)

(e) Suppose for R1=1Ω, R2=2Ω, R3=3Ω, R4=4Ω, R5=5Ω, V1=10V, V2=20V and V3=30V you obtain:
I1=+0.9091A, I2=-3.636A, I3=+4.545A
Find the potential drop across resistors R1,and R2. Provide correct SI units.

(f) Find the total power dissipated in the circuit with the values given in (e). Provide correct SI units.

(4) A coaxial cable consists of a thin wire of radius a and an outer conductor of radius b as shown.

The total current (I) on the inner conductor is uniformly spread over the cross sectional area so that the current density is $J = \frac{I}{\pi a^2}$. The same total current I is also on the outer conductor and is directed in the same direction which is out of the page. Let r represent the distance from the center of the wire.



(a) Sketch the direction of the magnetic field in region 1, region 2 and region 3.

(b) Find the magnetic field in region (2) in terms of the distance from the center of the wire (r) and the current on the wire (I).

(c) Find the magnetic field in region (3) in terms of the distance from the center of the wire (r) and the current on the wire (I).

(d) Find the magnetic field in region 1 in terms of (r). Hint: the area enclosed by a circle is given by $A = \pi r^2$.